

INDUSTRIAL MANAGEMENT

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PREFACE TO THE FIRST EDITION

WITH the confident judgment that in careful analysis of management problems is to be found the hope of industry, this book has been developed. Stress has been placed on general organization problems, not only in the chapters on organization, but throughout the text, with the deep conviction that if a satisfactory structure be developed for any enterprise, all other phases of management are simplified.

With the hope of stressing the fundamentals of sound management, which must be developed prior to granting attention to more spectacular phases, a number of chapters have been devoted to the background of present-day management policies, to organization as an abstract consideration, and too often-unappreciated standardization work. Throughout, the effort has been made to show the relationships of each major portion of the business to the others and the interdependence of the various major departments. Policies and principles of successful management form the background, into which are fitted the devices to carry them into effect, without which no management, however highly conceived, may be successful.

Operations have been treated with the belief that faith must be created in modern business, faith of the management in the employee, and faith of the employee in the management. They have been described with the thought that worthwhile management must be courageous, must be willing to lead, but must be always careful lest unprofitable experiments discourage future attempts to improve management methods.

The examples and illustrations have been chosen from a diverse group of industries in the hope of insuring that good management be looked upon as universally applicable.* At the same time they have been chosen from the standpoint of best explaining the problem at hand. Illustrations have been taken from particular plants, wherever practicable; but necessarily, for clarity and to reach fundamentals, applications have at times been made to insure full understanding of the general principles. In the main, the text has been developed from the point of view of the medium-sized plant, but frequent reference has been made to the large and the small enterprise. Such basic principles and policies as have been laid down are applicable everywhere, and only the systems and devices which carry them into effect must be modified as the size of the plant changes.

In brief, this book aims to present a co-ordinated, simple treatment of the problems, the ideals, and the methods of successful industrial management in a way which is at the same time broad and specific, and which aims to indicate the responsibilities of the factory executives to the workers, the stockholders, and the community.

During the preparation of this book, over a period of several years, the constant help and advice of numerous industrial executives has made possible the presentation of much of the material which is included. The author wishes to express especial appreciation of the aid received from Mr. Percy S. Brown, Works Manager of the Corona Typewriter Company; Mr. George Comfort, Works Manager of the Miller Lock Company; Mr. James M. Ketch of the National Lamp Works; and Mr. H. K. Hathaway, Consulting Engineer in Management. Mr. Charles B. Gordy, Assistant Professor of Mechanical Engineering, University of Michigan, and Mr. John S. Keir, Professor of Industrial Economics, Carnegie Institute of Technology, have also rendered criticisms and comments which have materially assisted in developing the text. During the preparation of the book continual constructive comment and criticism, and, indeed suggestions for rearrangement of material, as well as much of the material itself, have been received from the following, who are or have been instructors in the Department of Industry of the Wharton School of Finance and Commerce of the University of Pennsylvania: Messrs. Robert P. Brecht, John W. Carter, Leon Henderson, Victor S. Karabasz, Francis P. O'Hara, Norris M. Perris, Theodore R. Snyder, and Morton S. Whitehill. For reading the completed manuscript and making numerous valuable comments thereon, the author is very grateful to Professor Erwin H. Schell, of the Massachusetts Institute of Technology. He wishes to express his deep appreciation of the aid received from all these sources, to which such features of this text as may be valuable are largely due.

RICHARD H. LANSBURGH.

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INDUSTRIAL MANAGEMENT

PART I

INTRODUCTION

CHAPTER I

MANAGEMENT AS A BUSINESS FACTOR

MANAGEMENT, the unseen force which drives all that is physical within a factory, is by far the most important factor of the present industrial age. Machinery and materials may be put to work, workers may labor; but without adequate management to organize and consolidate them into a profitable, co-ordinate whole, to distribute the results of their work effectively, and to govern their operations during performance, this performance may become so uneconomic as to cease entirely.

We are accustomed to think of the physical thing, the huge plant, the wonderful machine, the useful product. We instinctively realize that some human force must have been called upon to create them, to bring them into being. But the methods of creating this force, of exercising its potentialities, until recently were little thought of, even by those who were in daily contact with its results. Most of us, particularly if we have lived in a large manufacturing center, see so much of the physical side of industry that we are likely to think not of the directing force, but of the result. We begin to regard enormous manufacturing plants, with their thousands of workers fashioning the product by combined effort, as one of the commonplace things of life. We seldom consider how these great plants came into being, how and by whom they were organized, or the effect of their presence and policies upon the economic life of the community.

Only as the flow of commerce is interrupted by a great depression or labor disturbance, and the machinery of the plant stops, while front-page headlines in the newspapers tell us the story, do most of us inquire concerning the basic management policies of an industry. Too large a number of business executives had the same tendencies in past days. Perhaps

the ever-pressing problems of the moment did not allow them time for retrospection or for policy planning; perhaps they were lulled into satisfaction by the cumulative results of a period of prosperity, which, instead of their own directive efforts, had acted as the basic management force for their particular business. Whatever may be the cause, strikes, unemployment, the cancers of industrial peace and prosperity, until recently were given nearly all the attention, while modest ailments and preventive medicine were overlooked.

The attention which our newspapers and periodicals now give our industrial life has brought to all of us a knowledge of the importance of industrial management in our modern economic structure. Not long after the beginning of the twentieth century this same knowledge was brought to many of our leading industrial executives, and the number of these men who have come to realize that successful management is the basis of all successful business operations is increasing constantly.

With this aroused consciousness has come the dawn of a new industrial day, in which the method of management, rather than the nature of the machinery, is the basis of the estimate of a plant's value to the community. A new concept of the industrial community is coming into being. Although we are in the midst of a period of transition wherein various factors in our industrial life seem to be irredeemably aligned against one another; nevertheless executives have come to talk of management, periodicals have come to talk of management, and the general public is beginning to realize that in the force of management lies the path to better understanding of industrial problems and through that to better community life. The test of the present industrial system is its ability to adjust itself to modern conditions. Management will largely determine whether or not it will meet that test.

Progressive establishments have been dealing for years with management as a separate business factor. They have realized the difference between drift and control in the operation of a business, and some of the outstanding business successes of the past two decades are tributes to the intelligent study of the hidden governing force of business. Gradually the gospel of careful thought in management has been spreading. Competition in methods of distribution, and carefully analyzed selling methods have made many concerns stop and look beyond the methods of the moment which they have been using. Hundreds of plants have been obliged to abandon the policy of drift by the cheaper production costs and the better working forces of their competitors. Carefully analyzed action has been substituted for the older methods of operation, and has automatically brought better management with it.

The extent of management, within several businesses, is found to vary greatly. In past years, it has been difficult for the observer, however

closely he may have looked, to see that management has been a very great factor in some plants. The physical structure has seemed to run itself. Even if a few units within an industry have focused their attention on management matters, competition within that industry has frequently not been such as to compel other units to grant much attention to management problems in order to survive, or even to make steady progress. Whole industries have pursued a policy of drift to the extent that they have been most unstable. Individual plants within an industry, interested in looking for profits without providing for them, have become a source of financial worry, not only to their owners, but to those financial institutions which have been granting them credits.

The financial institution and industrial management. The backbone of industrial economic organization to-day may be said to be the financial structure which allows businesses to operate on borrowed capital while turning their purchases of raw material and payrolls into the cash of the consuming public. For many years, the financial institutions engaged in granting credits to manufacturing establishments were accustomed to look primarily at the physical side of the plant. The balance sheet of the factory, as expressed in terms of machinery, plant and structures, raw material, finished product, plus accounts owed or receivable, was the basis of extension of credit, subject, of course, to influences such as goodwill or the individual reputation of the managing executives. This last factor was the closest approach which these financial institutions had made to an investigation of the type of management within a plant. Good management was presupposed, and yet poor management could waste the assets of the factory to such an extent that the figures on the balance sheet might become changed immensurably before the financial institution could clear itself.

Within recent years, banks have come to appreciate industrial management as a business factor. Though they still require the physical balance sheet to come up to certain marks of safety before advancing moneys for operation, those banks which have been giving factory business the most mature consideration have been going far beyond the physical balance sheet in estimating the worth of the plant. Many banks have specialists on their staffs, whose duty it is to survey the management policies of a business as a supplement to balance-sheet information. Certain consulting companies make a specialty of evaluating the management of industrial plants for bankers. Associations of bank credit men are distributing to their members facts concerning the organization of specific industries and methods of management within those industries. Thus the credit man of the bank is enabled to determine some of the more intangible, hidden, but fundamental points of strength or weakness in the financial condition of the industrial enterprise.

What is management? We have spoken of management, and of its position in industry, but as yet have not defined it. Management is a broad term and covers almost all the factors in the operation of an enterprise. It involves all the elements in the control of business activities, and may be said to be the correlation of the details of operation of an enterprise so that it will work as a harmonious whole toward the desired goal.

The goals of various enterprises may differ, as certainly the goal of a federation of charities would differ from the goal of a manufacturing establishment. In the main, the goal of all manufacturing enterprises is the same—profits in greatest possible amount to the owners of the business. However, this main goal is modified considerably from one business to another. One manufacturer will say that his goal is first and always profits; while another will say that, though it is true that he desires profits, yet he will not consider profits until his community of co-workers has a living wage. Another manufacturer may have a saving wage, rather than a living wage, as his prerequisite. In recent years many executives have reversed this point of view by holding that one of the aims of all businesses should be to pay high wages. They feel that unless high wages are paid, the purchasing power of consumers will be such that the product of industry cannot be absorbed, and hence profits will be low or vanish. The goals of enterprises also differ when profits are made in one case through large margins on small production, and in another case through small margins on large production. But in any case, the business that does not make a profit cannot long survive.

Business is organized for profit, and management methods that do not take this into account have proved of little value. Except in unusual circumstances, a manufacturing plant is not a laboratory for the trying out of certain management theories. Therefore, the first step that an executive takes in considering a management move is to ask, "Is it profitable?" or "Can it be made profitable?"

The general field of management is made up of three broad subdivisions: (1) the establishment of major policies, (2) the planning for, and setting up of, an organization to carry out these policies, (3) the operation of the enterprise through this organization. Reorganization work, which consumes so much of the attention given to management matters, consists of subdivisions of these three fields. As business conditions change, fundamental changes are needed in each of these fields. If a plant does not make changes from time to time, as needed, it sometimes becomes necessary to engage in an extensive reorganization plan, which, because of its spectacular aspects, may come to be looked upon wrongly as the main field for management effort. The best-advertised management work has been reorganization, because it is spectacular.

Management effort will call for the utilization of different types of genius, which are but seldom found in the same man. To establish policies and to plan for an effective organization requires mainly creative ability, though this must be coupled with some ability to visualize methods of executing the plans that are devised. To operate a plant along the lines which have been laid down requires mainly executive ability. The manager who has this gift, together with the ability to create new policies, is the effective manager of the first grade.

Our aim will be to study factory management that has been most effective, to understand fully the hidden power behind the physical plant, and to see how it may be utilized best. In order to fulfill our aim, three steps will be necessary: (1) to determine the policies and principles of good management; (2) to see how they have been applied successfully; and (3) most important of all, to develop a scientific state of mind toward management problems. In order that we may appreciate more fully what management is, and the position that it holds in our economic life, it will be desirable first to review briefly some historical aspects of American industry and the growth of management as a business factor.

CHAPTER II

THE HISTORICAL BACKGROUND OF INDUSTRIAL MANAGEMENT

THAT management has not received much attention until recently is not surprising if the historical development of our present economic structure be considered. A consideration of industrial history quickly indicates why industrial executives have but begun to give mature consideration to management problems. The whole factory system is young. In its brief existence there have been many foundation stones to be laid before adequate attention could be directed to operating technique and management.

The value of industrial history to managers. One of the most frequent causes of poor management and accompanying business ineffectiveness is the tendency to over-emphasize conditions which may exist at any given time. Even a brief study of industrial history helps to prevent glorification of the present and aids the executive to vision better the future policies of his enterprise. Every portion of industrial history will aid, whether it be the history of a period that closed long before the beginning of our immediate industrial epoch, or that of the ever-changing and important present. Possibilities of guidance and understanding lie in every period.

The significance of the fact that the relationships of capitalist, manager, executive, and worker, as we know them in Europe or in America, are at most but slightly over a century old must not be lost. Yet within this century the structure of our new industrial society has been changing constantly. Invention and the development of transportation and education have constantly increased human wants for manufactured products, and have increased the ability of the industrial world to satisfy these wants. Change has come to be the fundamental characteristic of manufacturing methods, both of technique and of management. What happened yesterday is of value in policy development, only in so far as it may aid in determining what may happen to-morrow.

Milestones in industrial history. The factory system is frequently referred to as the fourth of the milestones of industrial history, the first three of which are domestic production, handicraft production, and cottage production. However, the factory period itself is composed of divisions as nearly distinct as the several periods themselves. Domestic produc-

tion was production in the household for the members thereof, from raw materials furnished by the household itself. In its present form, found at any time only for a temporary period and only on the very frontiers of civilization, domestic production implies an entire absence of exchange and the ability of each household to satisfy the wants of its members entirely by its own labor.

Handicraft production was carried on either within or outside the house and is characterized by what is called "custom production." The handicraft worker usually worked for the consumer of his product, the region of the sale tended to be local, and the product of one craftsman might be bartered for the product of another, or an actual sale might take place. The rise and growing importance of the medieval towns upon manor sites, due to the development of means of communication, aided materially in developing this new era of manufacture. The development of handicraft production was accompanied by the growth of guilds, or associations of workers in the same trade, banded together to further their mutual interests. The growth of a particular guild in a town often caused that town to become the center of a particular type of manufacturing, and the guild controlled the town government as well as its trade. There was no large class of wage workers under the guild system, but each worker, having passed through his years of apprenticeship, could become a master of the craft. There was no employer or employee class. While the guild system was the chief economic feature of the handicraft period, in many towns there was sufficient demand for the work of a craftsman in a particular trade, but not enough demand to attract a body of men who could form a guild in that trade. Thus, weavers and smiths who were not members of guilds would be found frequently. They, however, had a similar economic position to the guild worker, dealing directly with their customers.

The control of guilds over production did not survive to the opening of the factory era, though, in a larger sense, handicraft production did. The gradual development of capital, the discoveries and explorations of the fifteenth and sixteenth centuries, and the consequent growth of trade together caused the power of the guilds to decay, partly because of their restrictive regulations, such as the strict limitations which they placed on the number of apprentices. The entrepreneur began to make his appearance in industry. The master worker or merchant who had accumulated some capital bought raw material and distributed it to workers, later collecting and distributing the finished product, either directly to consumers, or to merchants. In the sixteenth, seventeenth, and the early part of the eighteenth century, this method prevailed in the manufacture of staple commodities and became the forerunner of the factory system. This plan caused the era to be called the "cottage period" of industry,

since so much of the work was done in cottages just outside of towns. The workers still owned the tools of production, but the contact with consumers of their product was made for them by merchants.

The little manufacturing that was allowed to go on in the American Colonies prior to the Revolution may be thought of as being of the cottage type. Some of it was pure handicraft production, though practically without any associations resembling guilds.

There arose some few instances where workers were grouped together. In the sixteenth century there were a few "factories" where handicraft workers could be brought together and perform their duties under one roof. It is estimated that in Germany just prior to 1800 there were at least twenty such establishments, each employing between one hundred and five hundred persons. However, these factories were not only the exception, they did not represent any real change in methods of production or in the economic structure of industrial society.

As trade expanded and new worlds opened up, wealth began to be concentrated in the hands of capitalists, but there was no instrumentality through which this capital could be utilized so as materially to increase production.

The birth of the factory system. The birth of the factory system provided the outlet for this capital. The chief factors bringing about this new scheme of industrial production were four inventions made in England during the closing years of the eighteenth century, providing machines for the textile industry. James Hargreaves' "spinning jenny," patented in 1770, but in use several years before, was the first machine to spin yarn. This was improved upon in 1771 by Richard Arkwright in the invention of what he called his "water frame." This spinning device was so called because it was run by water power, though when he installed it in the first cotton spinning mill in England it had been run by horse power. In 1779 Samuel Crompton constructed his "mule," so called because its construction embodied features of both previous inventions. This device increased the potential production of yarn beyond the ability of the weavers to make it into finished fabric. This was directly contrary to conditions prior to the invention of Hargreaves' jenny, when the use of a "fly-shuttle" (practically a hand device) had given weavers a capacity for work that could not be met by the spinners. By this time, however, the invention of textile machinery had secured a fair start and the need was met by the fourth great invention, that of Edmund Cartwright's "power loom" in 1785. All of these inventions served, within comparatively few years, to revolutionize the textile industry—that industry which, possibly more than any other, is closely interwoven with human wants and human progress—and place it on a machine basis. Although it was not until the invention of the steam engine by James Watt, and its adaptation

to factory work in the closing years of the century, that industry broke away from the hampering limitations of the use of water power, nevertheless, the real Industrial Revolution, the change toward the factory system, had begun.

Similar inventions or changes in method took place simultaneously or shortly thereafter in many lines of work, particularly in metal-cutting. The slide-rest for accurately guiding cutting tools, the turret, and the combination of these two elements into the automatic lathe, by Christopher M. Spencer, of Connecticut, were the great epoch-making improvements in machine-tool construction, and these were all made at about this time.

Effects of the Industrial Revolution. The effect of the Industrial Revolution on such industries as were established in the United States was felt almost as quickly as in England, because once machines were set up, hand labor could not compete, if some means of fairly cheap transportation were at hand. Industry by industry, the Revolution changed all former manufacturing methods and conditions. The first cotton factory of any importance in the United States was established in 1790, but the Industrial Revolution is still going on. Its beginning, which rocked the very basis of industrial society, lay in those early inventions of the late eighteenth century. Yet as late as 1850, in the United States, some trades, such as shoemaking, had barely been touched by its influence, and the old conditions of master, journeyman, and apprentice still were characteristic of the industry. Such differences as there were in the effect in the United States and England lay in the fact that England was primarily an industrial country, whereas there was but little manufacturing in the United States. Therefore, the immediate effect on the social and economic life of the people was here less marked, though largely governed by the same influences.

The crowding together of many workers in a space originally meant for a few gained most attention among the economic developments following the Industrial Revolution. However, it was not the overcrowding of towns which was the great economic result of the development of the factory system. Factories had already been erected prior to the "four great inventions," and there probably would have been an increasing tendency to centralize work in larger units in any case. Neither is it the mere invention of machines with greatly increased production possibilities that constitutes the great significance of the Industrial Revolution. The real change is found in the new status of workers in manufacturing. It was the transfer of skill involved in the introduction of the factory system that brought about this changed status. Many of the conditions of modern industry are directly related to this transfer of skill. Included in these are the fact that workers of to-day are divorced from direct interest in the final product and the tools of production; and the fact that they have but

little control over conditions of work, except as conditions are limited by workers after the employer has taken the initiative.

Prior to the Industrial Revolution it was the worker who had the skill; now the skill is largely to be found in the machines. Prior to this time all machines were used to aid the worker in performing his task; now the worker aids the machine. The significance of the transference of skill will perhaps be understood better if a concrete example be taken. To-day, in shoe factories, the shoe-hand who can make a complete shoe is the exception. All can make portions of shoes well, owing to the lodging of the traditional craft skill in such machines as the welt-machine and the pulling-over machine. The skill of the trade and the inventor has been transferred to the machines, and an operator with but little skill or training can be taught quickly to handle the machine and turn out the product. Similar effects are marked in the metal-cutting industries, where careful study of the many machines will indicate that transference of skill is far more important than division of labor as a factor in producing monotony, fatigue, and other phases of industrial working conditions which the modern manager knows are unprofitable both to employer and employee.

Since transference of skill involves, at least temporarily, loss of earning power for the particular workmen involved, it is not hard to account for workmen frequently opposing the introduction of new machinery. The skilled worker found himself immediately and automatically degraded, in many cases, to the level of unskilled girls and boys, who could operate the new machines. This effect was not permanent in regard to the working-class as a whole. Large groups of workers were soon needed to produce the machines with which the others worked, and this, together with the general expansion of industry, afforded increasing employment for skilled men. Frequently, however, the individual suffered, as in the case of the skilled weaver, whose place was taken by the automatic loom, the skilled work on which was largely done by the metal worker, in an entirely different trade.

Opposition to new machinery began with Hargreaves' invention, his first machine being wrecked by a mob of spinners. It still is felt to-day in trades in which new machinery rapidly displaces hand labor, as in the recent introduction of the spraying machine in the painting trade. Opposition to the introduction of new devices may be directed toward machinery which itself increases output or absorbs workers' skill. However, it often has been directed toward devices or management methods which study processes or measure output in order that management may know better how and how quickly work should be done.

The effects of the transference of skill were far-reaching and complex. One immediate effect, and one of the most significant, was to separate the worker from the ownership of the tools of industry. No longer was it

possible for the apprentice, becoming a craftsman, to be presented by his proud mentor with the implements of his trade. Capital was now required both to build these new implements and to provide power to operate them. The rise of the capitalist class, already begun, was therefore necessarily accelerated. The immediate results, particularly in England, of the rapid rise of this newer class in society and the accompanying degradation of the worker are well known. The study of the sufferings of the English worker of the early nineteenth century should be carefully read by all who desire to express positive views on the relationship of capital and labor. Had it not been the day of the economic doctrine of "laissez-faire" and had not Britain been engaged in a long series of foreign wars, the industrial history of that period might have been different; but it now stands as the historic example of frightful working conditions—child labor to the point of death in childhood, and general inhuman treatment of the worker. It was but the natural result of too-rapid transition from one economic era to another.

The factory system in the United States. The immediate results of the Industrial Revolution in the United States were less deplorable socially because the country was new, manufacturing was relatively unimportant, and full opportunities existed in agriculture for any industrial worker who might fall under such conditions as those existing in England. When the manufactures of the United States began to grow in the second decade of the nineteenth century, the factory system was established, and its social effects were not so severe as in Europe where different manufacturing conditions were overturned.

The factory system in the United States to-day bears no resemblance to that of 1850 and very little to that of 1880. There have been fairly distinct periods, during which various aspects seem to have been more important than others, but no fine limiting date lines can be set for each period. The three most important divisions have been: first, that in which the structure was started and the foundations laid; second, the period of great industrial expansion; and third, the period of attention to operating methods.

The beginnings of American industry. The first period is characterized by small factories, patterned basically along European lines, with relatively narrow markets and organizations dominated by the owner, or capitalist. The growth of a middleman organization and a financial organization to market the rapidly increasing product of the factories also is characteristic of this period. American manufacture had, as a basis for its early growth, the transplanting of European industry, almost bodily, to the shores of this country. European workmen, European machinery, frequently European superintendence and even European raw materials, formed the entire groundwork for the establishment of our early manufactures.

The trends in the early development of an industrial system for our industries were only a repetition of the path of those same trends in Europe, particularly England, modified to fit the American environment. This was a period when immigrant workmen, who had landed but recently in America, were frequently sought after by plant superintendents in order that the latest technical advances in European manufacture might be learned.

Though markets were broadened in the first half of the nineteenth century by transportation advances, such as the beginning of railroad building, yet they were comparatively narrow, compared to the markets that we know. Though the limitations of state boundaries meant nothing when compared to those of national boundaries in Europe, yet it was unusual for one manufacturing community to attempt to sell in another, except as it possessed some product not made in the other locality. Means of communication usually did not allow national distribution to be attempted. Nevertheless, markets were constantly broadening, and groups in the community began to arise to take charge of the marketing function. The development of the merchant class, which, we have seen, was in existence long prior to the formation of the manufacturing-capitalist class, quickly progressed. The structure comprising the jobber, wholesaler, and retailer, with which we are familiar, grew up. Trade customs came to be established, as in branches of the textile industry, whereby all goods were produced primarily for a middleman, who took over all phases of the marketing.

A financial group arose whose business it became to provide the means of carrying on the rapidly increasing transactions between these newly established groups of industrial society. The larger the competitive area over which a product was distributed, the more necessary became the services of the financier; thus his growth to a dominating position in industry followed the increasing development of markets.

The characteristically small plant of this period was dominated by the owner, who was usually to be found in the factory during working hours, except when engaged in distributing his product. Workers found opportunity for personal contact with the owner of the business, and frequently for personal expression of their craftsmanship in the finished product, even to the extent of changes in design. The owner, whether he was on good or bad terms with his men, was well known to all of them, sometimes by the half-affectionate title of "the boss," and generally to many of the older employees by his first name. The worker was accustomed to remain at his place of employment for years, the personal contacts which he formed with the owner doubtless proving to be one of the strongest inducements in this direction.

Despite this opportunity of personal contact, labor troubles were

numerous, and could hardly be called less violent than those now experienced. They were, however, sporadic and unorganized. Strikes occurred, many being caused by the attempt to bring into manufacturing the long hours of agriculture. It was many years before the ten-hour day became common, and this was secured only after constant struggle. The governing philosophy of modern management had not even caught a foothold in the industry of the time. There were many attempts to form labor organizations, some of which were successful for a time, but there were no national union organizations, such as those with which we are familiar. Those that were successful were local associations of local workmen in specific trades.

In this early period, manufacturing was not regarded in any sense as a science, but primarily as a vocation. Utilization of scientific methods in developing manufacturing technique had but begun, while close checks on leakages through accounting methods or management control were not even thought of.

The period of great industrial expansion. The second period, that of the great industrial expansion, saw the United States rise from the position of a novice among nations in manufacturing industry to the position of the greatest manufacturing nation of the world, both in diversity and amount of product. Abundant natural resources, a rapidly increasing home market among people whose wants were large, and manufacturing ability which seemed to combine and intensify the variety of skill of the many population elements caused this growth in manufacturing industry.

The United States, a new country, willing to absorb and further develop new ideas, readily secured the benefits to be found in the logical development of the factory system. The division of labor which resulted from the first machine inventions was further increased as manufacturing method under the factory system developed. With each invention of a machine, division of labor was likely to increase. Transfer of skill to machines made possible the reduction of manufacturing costs, which brought wide markets that made possible increased production. As production increased, economics in the purchase of materials, indeed, the control of sources of supply of materials, became possible. Integration of the various steps in production of raw materials and manufacture of more and more refined products became possible. As size of industries increased, more and more capital could be attracted, which made possible further development of integration, mass production, and by reducing costs, widened the markets. Capital began to be used as a means of founding and financing huge enterprises which could not have existed without its aid. In the adaptation of all these conditions, the lead was taken by the United States, which, instead of being the pupil, came to

be the teacher in most phases of manufacturing promotion and manufacturing method.

With the foundations of a huge domestic market already laid in the first period, the development of means of transportation and communication, beginning early in the last half of the nineteenth century and reaching to the present, literally made all the world a neighborhood in which products purchased are made through a radius of thousands of miles. While markets have been broadened, the ability to secure raw materials has likewise expanded; even workers move from one locality to another as conditions dictate, and thus competitive conditions have been made over. The service rendered industry by improved communications cannot be measured; without the growth of the railroad map and railway shipping accommodations and service, taking place simultaneously with the development of the telegraph and telephone, which make possible the dissemination of news and market information, there could have been no such industrial growth as has occurred.

The invention, by Watt, of the steam engine helped to revolutionize industry, but the development of the dynamo and electric motor created real industrial power. The first machine inventions brought in the factory system, but constant inventions and improvement increased the capacity and technical efficiency of industrial plants to undreamed-of proportions in those same industries. Invention during this second period of American manufacture founded great new industries, filling new wants and creating whole new markets. A rising standard of living broadened the market, which for these and other products might previously have seemed glutted. We look upon the great iron and steel industry as the barometer of our trade conditions, and yet, ninety years ago, the iron on railway tracks consisted of a thin strip laid on top of wooden or stone rails, while steel frame buildings are a development of recent years. The use of electricity for power, communication, and light has founded but recently one of our great basic industries. The successful use of the gasoline engine for transportation purposes has given us within the last twenty years the automobile industry, one of the truly great industries of the country, whether it is considered from the standpoint of value of product, number of people employed, or manufacturing method. The beginnings of all these industries, the improvements in manufacturing technique, the improvement in product which followed and broadened the market for each, are all characteristic of the second period in American manufacturing.

As manufacturing grew, and new industries developed, there was developed the "American type" of manufacturing, the production of standardized, interchangeable parts. American manufacturing had developed so rapidly, under conditions entirely different from those of Europe, that it soon found itself practically free from the bonds of European influ-

ence. Indeed, it became so free and so accustomed to look upon American methods as best, that it actually made competition with Europe in export sales difficult by refusal to observe trade customs and desires in foreign markets.

The growth of markets, necessarily involving greater production, brought about a rapid increase in the size of those companies which had marketed needed products of either high quality or low price. The increasing size of the enterprise, the necessity for large amounts of additional capital, and the legal advantages incident to the corporate form of organization combined to make large corporations the backbone of the manufacturing industry of the United States.

It is the difference in the size of organizations, rather than their form, which is responsible for the changes in owner-worker relationships which occurred. However, in many corporations the owners became so distinct from the management as to cause the growth of new operating problems.

The rapid growth of manufacturing created a demand for workers, which which could not be filled through the ordinary growth of population, but only through heavy immigration. In the days when cheap labor was one of the outstanding needs of American industry, this immigration was of great service to the development of industry; but as mechanization has reduced the need for cheap labor in industry, the existence of large, unsimilated and un-Americanized groups of workers has produced personnel problems in many factory communities.

The growth of labor unions, organized along present lines, is another of the developments of this period. They exist as the crystallization of the labor movements of earlier American industry and of forces in existence since the guilds. They also exist in direct response to conditions caused by the growing impersonality in the operation and incorporation of manufacturing enterprises, as well as in response to the necessities of self-protection brought about by the flood of immigrants in the last part of the nineteenth and beginning of the twentieth century. As corporations have grown in size, labor organizations have grown in size, that they might be able to match strength with the employers. As organization, national in scope, has been achieved among employers, similar organization has been perfected among workers. Many employers to-day must deal single-handed with national unions, but yesterday many workers had to deal single-handed with fully organized local employers' organizations and sometimes with national organizations. This is a partial explanation of the "organized employer, organized employee" situation as it is found at present in those industries in which organized labor has obtained a foothold.

Fundamental conditions which called for attention to operating methods. Even as, after wars of conquest, nations have found it necessary to go carefully over the captured territory inch by inch and put it in order,

and while doing so have had to change their army of occupation from one organized for conquest to one organized for administration, so the manufacturing community in the United States has had to go carefully over its conquests and reorganize. It has had to reorganize at the same time that it has been making more conquests, conquests in the field of new markets, in the direction of new inventions, of mechanical improvements, and conquests in the bettering of social conditions of the worker. Manufacturing industry in the United States expanded rapidly through the help of many separate, unorganized forces, some of which were normally opposed. Technique was bettered in production and attempts made to widen markets without much thought of correlation. Individual experience in operating methods was not disseminated, nor was it classified. There was need for considering plant management along with technique in manufacturing.

The opening of the third period. Attention to operating methods. Gradually, manufacturers in many lines began to find that their normal productive capacity was greater than their market. Although market demands had increased with a growing population, increased standards of living and the development of new products, manufacturing capacity had increased even more. Many companies were also beginning to give attention to economies in production and accurate cost-finding methods that gave them an advantage in fixing selling prices. Rivalry within industries caused plants to lie idle for lack of orders, and to begin to combine with competitors in an effort to reduce distributing costs and overhead charges, as well as to provide production economies. National advertising came to be a major factor in distribution methods, in order that markets might be enlarged and trade secured from competitors' customers. Great inroads began to be made on the jobber-wholesaler-retailer method of distribution, which previously had characterized American industry. These changes marked the opening of the third period.

The scientific industrial age began to arise out of the changed conditions, and attention to methods of operation is the outstanding feature of this era. Savings through better organization, savings through stricter accounting, savings through more effective distribution, and savings through more effective factory operation, all are considered, thrashed over in executives' meetings and adopted as a portion of plant policy.

The tendency toward the creation of larger enterprises has continued and to some extent increased. At least, there is a definite tendency to create "interests," which control many enterprises from a central location. The giant corporation, owned by hundreds or thousands of investors, has become common. This implies control of many plants through operating or managing representatives of the owners, financial representatives, sales representatives, and production representatives.

In this lies an additional cause of attention to operating methods. In such types of organization, attention to management is essential and fundamental; huge organizations must be constructed so that they will function as smoothly as the huge machines in the factories. The gears of policy of the finance, sales, and production organizations must mesh as closely as the driving gears on the factory lathe. They can only be made to mesh if minds and hands guide them to that end.

Effects of the Great War on American industry. With the entrance of America into the World War, factories that had been making one article or type of article for years suddenly found that this article was of no service in carrying on the War, and that priorities and restrictions against the use of certain materials practically prohibited their manufacture into peace-time goods. Through necessity and urging they turned to the making of entirely new articles. In the normal course of events, the old production methods of these plants might not have changed, because they were prospering quietly, but they were now face to face with new production problems.

They were forced to think in new channels, to think of operating methods to produce the new products quickly. This habit that they formed in war times they carried to peace times, and it is unusual to find a factory that was engaged in making war products that has not had its peace-time operating methods changed through being forced out of the well-worn ruts of years of operation. There were other similar effects of the War, as we shall see later when considering the management movement separately.

The War ended with distinct unrest among a large percentage of the wage-earning group. A considerable part of the immediate unrest could be traced rather directly to many men who had been taken from the workbenches for the first time, shown other fields and, in general, made desirous of change, whatever that change might be. But something fundamental to industry came from the War. There came into the minds of all, employer and employee, an increasing sense of the importance of the individual worker in industry. Whereas, prior to the War, the emphasis in management matters was given largely to the physical aspects of management, such as plant, equipment, and materials, the emphasis since the War has been equally on the human element. Despite the trend toward increased mechanization in American industry, there is seldom a step taken toward changing the physical aspects of a manufacturing plant without being first evaluated in terms of the human element. The results at times take the form of worker representation in management or collective bargaining between employer and employees; but more important than these is the frank consideration which is given to the workers' point of view in every management step.

There has come to be an appreciation of the fact that wage-earners must have the same desire to work steadily for and produce for "the organization" that they had for "the boss," and that there must be found something to substitute for the appealing force of "the boss's" smile. New departments in industrial establishments have had to be created, not only to improve processes and methods of production, but to improve the human understanding within the organization, to acquaint each with what the others are doing and why they are doing it.

At the beginning of the factory period, the employer and the manager were one and the same. Later as capital came to be accumulated in larger amounts, the capitalist frequently ceased to be active in the business which his efforts had made possible. With the growth of the great corporation this distinction between the capitalist, or owner, and the manager, or operating head, has become more and more intensified. Owners are scattered over large areas, but the operating heads must be near the business. This condition has been of real advantage in building up a technique of management, and in creating a group in the community whose paramount interest is the effective operation of industrial companies.

This condition, in turn, has caused much attention to be devoted to the industrial possibilities that lie in the relatively small plant, the plant of from two hundred to five hundred workers. Here the actual owners and those who develop the policy can keep in contact with the wage-earners, and elaborate management mechanisms can be dispensed with at times. This condition can be advantageously contrasted with the impersonal "drive from above" so frequently found in large corporate organizations that are a portion of "interests."

Yesterday the factory system was developing and machine production was growing; to-day the machine is more important than ever, and unbelievable strides are being made in having machines do to-day what workers did yesterday. Industry in the United States is contrasted in no more vivid way with industry in Europe than in use of power, and hence mechanization of process. With a use of more than ten horsepower per capita in the United States, power consumption is nearly twice per capita that of the greatest power-using country of Europe, England.

To-day management predetermines costs so accurately that all the possibilities of the application of power through a machine are known before that machine is ordered. Careful analysis of present equipment is made, and the relation of a new machine to productive equipment already installed, and an analysis of labor costs with the old and new equipment are the bases of the purchase of new equipment. Yesterday employers were but employers; to-day, if the employer does not himself manage, he must hire a manager. The large variety of detail cost elements in a busi-

ness must be analyzed and weighed carefully, and decisions reached from this scientific process.

The industrial scene has changed, and the change is becoming more apparent year by year. There are some employers, some large corporations, even, that are living in the era of yesterday. Some may still exist because of particularly favorable conditions which give them monopoly power; but others live in that era without such protection, not realizing that they are in danger and that the industrial world has moved onward another step into the era of scientific operation. Many such enterprises are "taken over by their bankers" during times of depression.

This age of management in industry is new. Though industry is centuries old, the factory system has existed for little more than one century, and the conditions of modern industry that have given rise to present-day management problems, for only a few years. The very youth of the present economic conditions is the cause of many management problems that now exist. The science of management is a new one, with even its shallower waters unsounded, a science wherein every factory, every organization, is a new world, and every worker in industry a potential explorer and a prospective discoverer.

CHAPTER III

THE MANAGEMENT MOVEMENT

COINCIDENTLY with the rise of interest in management matters among the general industrial community, there has been developing what may best be termed "the management movement." This movement, which involves personalities, has been progressing together with industry and yet separately from it, actuating industry almost from without. By considering this management movement separately it becomes possible to trace more definitely the various stages in the changes that have been occurring. A discussion of this movement will also aid in clarifying some issues, and possibly in eliminating doubts.

Fundamental factors in the industrial situation, some of which have already been pointed out, would have caused the management movement, in some form, to have come about within a period of perhaps a quarter-century. Of that we can be certain. However, the exact form of the movement and its starting place were determined, as is not unusual, by the life work of a great man. This man, seeing around him the need for the development of management, even as many other men probably saw it, was not content merely to sit and look on, but began the intensive study of corrective measures, which finally led to the development of the science of management, of which he is recognized as the founder.

Frederick W. Taylor. Whatever branch line the management expert may be working in at the present time, or whatever methods he may use in his particular development of the science, the true expert, who has studied the history of the movement, as well as the detail of method, will always gladly say that his work is but the development of the foundations laid, between 1880 and 1890, by Frederick W. Taylor. Taylor was the man with the vision, the father of modern scientific industrial management, not only in the United States, but throughout the world. There never has lived a man whose individual work so largely influenced the operation of so many plants in so many and diversified industries as did the work of Frederick W. Taylor. His first work was small in itself and was finally largely voided by opposing factions. His influence, though not dormant, was both consciously and unconsciously disregarded for twenty years; and yet, in the development of management methods, it has been greater than that of any other single man.

Taylor was himself strongly influenced, when still comparatively young, by knowledge of the work of Henry R. Towne, then President of the Yale and Towne Manufacturing Company, who began the application of new management methods as early as 1870 in the plant of that company. It was probably the example of Towne that caused Taylor to direct his efforts to the organized study of management as a science and as a profession. But, although Towne may have been the pioneer, Taylor was the great leader of the movement. At the time of Taylor's death, Towne himself referred to him as "one of the world's discoverers and creative leaders," and as "the creator of a new science."

Early steps of Taylor. In 1882, after transferring from the offices to the shops of the Midvale Steel Company, in Philadelphia, Taylor was promoted to machine-shop foreman in the Midvale plant. During his previous experience as a workman, Taylor had been constantly impressed by the failure of many of his fellow-workers to produce more than a third of a good day's work. Wages had been on a piecework basis, and the men were afraid to let the management know how much work they could really do, for fear that the rates would be cut. When Taylor became foreman, he was determined to work out some system of management by which the interests of the management and of the men might be made as nearly as possible the same.

The constant thought in the mind of Taylor in those days was that the difficulty at the root of the whole matter was lack of knowledge of what actually should constitute a day's work. How could the man be held accountable for his full duty when the management had no idea of the man's capacity? It was on this thought as a foundation that most of his writings, researches, and influence over other men were erected. He found that management did not really manage. It would be necessary to change entirely its attitude toward its responsibilities in this direction before it could be expected that the workman would change his attitude with relation to his work. Taylor felt that the management was asking the worker to do its work as well as his own. His efforts to secure information at Midvale, concerning ways in which management might really manage, enabled him to develop what he termed the "duties of management," that guided him and many others along newer industrial paths. These duties were changed in phraseology by Taylor from time to time, but their substance was as follows:¹

former practice of allowing the worker to select his own task and train himself as best he could.

Third: The development of hearty co-operation between the management and the men in the carrying on of the activities in accordance with the principles of the developed science.

Fourth: The division of the work in almost equal shares between the management and the workers, each department taking over the work for which it is the better fitted; instead of the former condition in which most of the work and the greater part of the responsibility were thrown on the men.

Taylor remained at Midvale until 1890. While there he also carried on early experiments in the development of high-speed steel. His discovery of this product, in which he was associated with Maunsel White, ranks as an achievement equal to the founding of the modern management movement. The work which he did on high-speed steels was in fact an outgrowth of his attempts to find the right way to do jobs. When Taylor left Midvale it was largely due to factional differences within the organization, and this fact naturally led to the undoing of much that he had accomplished. Nevertheless, even to-day many of the practices in the machine shops of this plant can be traced directly back to the time that Taylor was first working with management methods there.

For several years Taylor did not have an opportunity to carry on, upon a large scale, the work that he had begun at Midvale. Though engaged in a number of undertakings in which he aimed to improve management method—several of which, by the way, were largely concerned with improvements in cost accounting—there was no one great work carried on in one plant.

At the Bethlehem Steel Company, beginning in 1898, for three years, with the assistance of a large and competent force of assistants, he reorganized the management and methods of two of the larger machine shops and the foundry, and at the same time completed the development of his metal-cutting experiments. It was at Bethlehem that interesting studies of pig-iron handling and shoveling were made, which since have become classic in the field of management. One of the more important of the wage-payment systems was also developed during this time. Taylor's early experimental work in management can be said to have been done on the same sound scientific basis as his metal-cutting experiments. This fact accounts for the fundamental nature of his conclusions. As an evidence of the type of work he carried on, Taylor once stated in connection with his metal-cutting experiments that he and his associates had made nearly fifty thousand recorded experiments and many others of which no record was kept. In studying the laws of metal-cutting there were cut

up under his direction more than 800,000 pounds of iron and steel. His experiments in management were conducted on the same scale.

After Taylor had been at the Bethlehem Steel Company for about three years there was a change in the directorate and executive management of the company. The group who came in were unfamiliar with, and apparently antagonistic to, the methods pursued by Taylor and his staff. Taylor and his associates left. This withdrawal was followed by changes in method by the new management, and since it so closely followed the upheaval at Midvale it cast a shadow on Taylor's work which it took some years to live down. This accounts for the slow development of his ideas during the immediately succeeding years. The manufacturing community as a whole, if not actively hostile, were at least reluctant to give a trial to ideas which had been practically discarded at two of the largest steel plants in America. But Taylor's work had trained a number of disciples, who thoroughly believed in his ideas and work, and there naturally were enough manufacturers who were interested in these new ideas of management to allow for a steady, if slow, growth in their application during the succeeding decade. Among the more important plants in which Taylor or his direct associates worked in this period were the Tabor Manufacturing Company and the Link-Belt Company of Philadelphia and the United States Arsenal at Watertown, Mass.

Taylor's later life. Shortly after the beginning of the twentieth century, Taylor withdrew from actively installing management methods and began to philosophize and generalize on his experiences. The far-reaching significance of his principles and methods became clear to him and he began the task of transmitting them to others through writings and addresses. His writings of this period have become the very foundation of modern management literature. The first and best known of these is "Shop Management." This book was first published in 1903 under the auspices of The American Society of Mechanical Engineers, having been read at a meeting of the society in June of that year. In December, 1906, Taylor presented as his Presidential Address to the same society his other masterpiece, "The Art of Cutting Metals." From that time until his death on March 21, 1915, he devoted himself almost completely to the task of spreading the gospel of scientific management.

After Taylor gave up the active practice of management installation, there quickly appeared a number of his direct followers to carry on his active work. These men became known as the "Taylor School" in management methods work, because their close association with the leader of the movement caused them to be guided largely in their work by Taylor's own methods. At the same time, the influence of Taylor was guiding other men along paths which led to the same goal in distant parts of the

United States, and even in other countries. In the hope of finding methods that would avoid some of the pitfalls that befell some of Taylor's detail methods at times, these men developed other methods which frequently seemed far different from those of Taylor. Though the devices differed, the principles, if the work was sound, were Taylor's. In fact, even when opposition still existed to Taylor's work, manufacturing executives who thought themselves opposed to Taylor were in fact following frequently the very lines of thought that were primarily his. This was due to the wide diffusion of Taylor's principles through his disciples, and also to the fact that his principles were basically sound for the era into which manufacturing was entering.

Taylor's position in the management field is that of the first thorough explorer. His researches, because of his personal ability, carried him further than might have been expected. Unfortunately, he was not a salesman, as far as his own work was concerned. Those close to him were always able to see the careful thought and study behind his conclusions, but others did not have this advantage.

The public, and even a large percentage of factory executives, not even excluding the metal trades, did not have their attention focused on scientific management by any of the early work of Taylor or his followers. Although there had been a constant improvement in management methods, and many men were already making management service a life work, in 1910 scientific management had not captured the fancy of any large portion of the industrial world.

The railroad-rate hearings of 1911. In 1911 thousands obtained a general idea of the meaning of scientific management as a result of a startling announcement made during hearings before the Interstate Commerce Commission, late in 1910, concerning certain railroad-rate increases. Mr. Brandeis took the aggressive against the proposed increase, stating that it would be unnecessary if the railroads of the United States should adopt scientific management. He explained that, by this method, a saving in operating expense could be accompanied by an actual raise in the wages of railroad employees. At these same hearings, Harrington Emerson, who had wide experience in developing management methods in the shops of the Santa Fé Railroad, stated that the railroads could save \$1,000,000 a day by paying greater attention to efficiency of operation. These two statements, both coming from men of undoubted reputation, were given wide publicity, and electrified the entire country. High-school debating teams joined technical experts in discussing the situation. It was fortunate for the growth of the management movement that public attention was focused upon it first in connection with an industry with which the public came into daily contact.

The early December magazines, published only a few days after the

introduction of the evidence, gave much attention to the dramatic testimony of the witnesses. In March, 1912, the first management society was formed in New York, and scientific management as an element in the industrial life of the United States had come to stay and grow.

The "efficiency men." Modern management shortly came to be known under the term "efficiency" and interest in "efficiency" became so widespread that it nearly caused the death of the management movement. It did retard it. "Efficiency men," fakers in every sense, who promised short-cuts to profits through panaceas, and whose knowledge of management was as shallow as their vision was narrow, sprang up overnight. They managed to kill the word "efficiency" in American industry most promptly, and they nearly permanently injured the management movement. They failed for various reasons. They usually had no knowledge on which to base their efforts. If they did have the personal experience to qualify them, they usually lacked the broader concepts which would have permitted their work to be successful. They did not pay sufficient attention to the workers' point of view and they did not or would not co-operate with the regular organization. They tried to run rough-shod over the older members of the organization until the title of "efficiency man" became everywhere the keyword for concerted opposition. Recently the "consultant in management," with far different ideals and qualifications, has replaced the "efficiency man," with very effective results.

Another retarding influence on the growth of the management movement at this time was the fact that all the literature on the subject concerned the metal-cutting trades. When a manufacturer in another industry became interested in modern management and began to read Taylor's writings, or those of his co-workers, he soon discovered that everything definite was expressed in terms of metal-cutting. It was, therefore, but natural that they failed to look, under the surface of the devices and terminology employed, at the principles involved, and said that "it didn't apply to them." It was some years later before this difficulty was overcome even partially.

In the general growth of the management movement, the leadership that had been Philadelphia's was largely lost. Sections of the country which were less conservative along lines of management method took to the new ideas more readily and in larger proportions than did eastern sections. New industries which were developing, such as the automobile and allied industries, had a made-to-measure opportunity to develop management method along with manufacturing technique. These were largely located in the Middle West. The Middle West grasped at the opportunity of increasing effectiveness of operation that was offered by management method and gradually developed, in many scattered

localities, methods of operation which, though built up on the same firm foundations as those which served the early leaders of the management movement, were nevertheless constructed along newer and bolder lines. Of the illustrations of this work, the best known is that of the Ford Motor Company, whose examples of the economics incident to standardized operation, continuous assembly, and newer wage-payment concepts have profoundly influenced the whole of American industry.

The management movement at the beginning of the War. At the time that the United States entered the World War the management movement may be said to have been in a condition of deflated interest but gradual growth. The necessities that were outgrowths of our entrance into the War quickly changed this situation to one of awakened interest and rapid growth. The declaration of war by the United States, in April, 1917, made it incumbent upon this country to organize itself for the prosecution of the war immediately and effectively. It meant the organization of the industries of the nation for the one common purpose.

Those who were in control of Government supply bureaus very quickly found it advantageous to employ for the organization of war-time industry men who had made a business of organizing peace-time industry. Large numbers of leading manufacturing executives, and practically every man who had ever written an article on management, were to be found connected with one of the Government departments before the War was many months old. Thus manufacturing executives who had not yet come into contact with the management movement came to know the ideas and methods of scientific management men in a way that otherwise would have been impossible. Although it is true that some of the executives returned to industry with a horror of attempting the methods that they had learned, the usual reaction was the reverse.

The effect of the War on the management movement. Most of the executives returned to their peace-time tasks with new ideas and new concepts, and, above all, jarred out of the habit of doing things in an accustomed way. The war also broadened the men who had been the very leaders in the management movement in prior years. They went back to industry after having gone through the same situations which made for greater attention to the human factor in management after the War. Perhaps it was their contact with men of industry, perhaps it was merely the broadening influences incident to getting into other work for a time. In any case, management men seemed now to possess a more fundamental concept of their proper position toward labor. They now had a feeling of trusteeship of the rights of labor, as well as a trusteeship of the rights of the owners of the business, which they had long felt. Since the War, all those connected with the management movement have been leaders in the development of new concepts of human relations in industry.

The consultant in management. Since the War the spread of the management movement has been extremely rapid, and the development has been along what seem to be comparatively sound lines. "Efficiency" has passed on, and in its stead has come soundly developed management work that considers the fundamentals of all problems, that is based on long perspective, and that takes into account the necessities of both booms and depressions. Management has become the profession of the plant executive, not merely the profession of a few who specialize in it. Those who do specialize in management fit into the scheme as specialist co-operators with the managing executives of industry. The consultant in management has become firmly entrenched as one of these specialist co-operators. He fills a very real, although a new niche in the halls of industry. He is a combined product of the age of management and the age of specialization in industry. He specializes in management and sells his services, either along general or specific management lines, to the executive who is in charge of the enterprise. He brings to one plant the knowledge of many, and he serves to rehabilitate run-down concerns by bringing in the refreshing stimulus of an outside viewpoint. He serves the same purpose as does the blood-transfusion operation at a hospital, and at the same time his greatest work is carried on before the patient-concern gets to the point of weakness such as characterizes the hospital patient who undergoes the blood-transfusion.

The specialist, or consultant, in management is not the only expert who is a product of recent development in industry. He has come in after the certified public accountant, who occupies practically the same position in the accounting field that he does in the managerial, and his advent is not so recent as that of the income-tax expert, whose duties frequently partake more of the legal nature than they do of the accounting. Some of the more recent developments in the field of industrial consulting have become rather specialized. For instance, there is the type of industrial consultant who advises only with regard to the construction of a new building or the remodeling of an old one, specializing in such matters as the type of building construction, fire hazard, or the routing of the product through the factory. There is a still more recent development, the consultant who deals only with labor matters. Mushroom consultants have sprung up who are but remnants of the efficiency men, but in the main the consulting field is developing along far sounder lines than did the efficiency movement.

Together with the growth of the consultant, has come the growth of the "methods man" or "methods department" within the organizations of businesses. This specialist, or department of specialists in management, is continuously on the payroll of the employing concern. The members of the methods department have no particular duties connected with the direct

administrative work of the company, but act entirely as specialists in management, advising, and developing new ideas. This group in industry are an important part in the progress that the management movement is making, for they have the advantage of daily contact with the management problems with which they deal. The consultant is of service, even to them, for he brings the experience of many organizations to help in a solution of the problems that confront them.

The future of the management movement. Fortunately, the management movement and its leaders have been able to progress away from the idea that the future of management is bound up inseparably with some particular staff department or some device. The management movement is behind the scientific method of attack on problems of business, but it stands no longer for any particular device or set of devices as being the only scientific method of attack. Staff departments which once seemed inseparably attached to any form of scientific management have been eliminated by some companies in times of financial stress, and still scientific management method has been used by these companies in attacking their problems. The true scientific approach to the question of development or abandonment of a particular department of a business is the study of the service that such a department might render or has rendered, compared to the cost of its operation.

Periods of financial stress in industry, instead of retarding the management movement, as they once did, now help it on, as examples of well-managed plants that foresaw and weathered the storm through good management methods have become well known. Organized labor, often hostile to management developments because of misunderstandings or poor operating methods in particular plants, has come to be more friendly, partly because of the ability of well-managed plants to provide employment at regular wages during depressions.

Organized labor itself has become a part of the management movement. "We urge upon management the elimination of waste in production in order that selling prices may be lower and wages higher." This statement was contained in a resolution adopted at the convention of The American Federation of Labor in 1925. Labor realizes "that its future welfare and best interests are interdependent with industrial progress and business prosperity, and we are placing a distinct emphasis on proposals that will lead to opportunities for co-operation." This is quoted from President William Green of the American Federation of Labor. Surely this means much for the management movement, for, because of misunderstandings, organized labor was once avowedly opposed to studies of production waste.²

There are a number of other factors which are combining to insure

² See Hearings before Special Committee of the House of Representatives to Investigate The Taylor and other Systems of Shop Management, 1912.

steady progress for the management movement. Among these are the growth of societies whose membership consists largely of plant executives and whose interests lie entirely with management problems, the increasing literature, both periodical and book, on management subjects, and the attention being devoted by the next generation of factory managers, now in educational institutions, to management as a study.

Just as the growth of scientific education in colleges during the last fifty years has aided in revolutionizing American industry, so the growth of management education is likely to aid the management movement in further revolutionizing it. In 1915 there were not five courses in management given in American universities. To-day practically every business and engineering school in the United States is offering courses in management. While this extremely rapid growth of management instruction has been in response to the demand from industry, yet in many cases it has led the demand, and has, through its graduates, called the attention of industry to the strides that have been made in management in other sections of the United States. This must be put down as one of the most important developments in management in recent years. Particularly is this true in the instances where industry and the colleges have co-operated in management education, for in practically every case where this has occurred, the combination of practical and theoretical instruction has resulted in very distinct advances in the management field.

PART II

ORGANIZATION

CHAPTER IV

FUNDAMENTALS OF ORGANIZATION

ONE of the primary steps in management development in any enterprise is proper organization. After the business has been conceived and the broad policies which are to be pursued have been established, before any operating methods may be devised, at least a skeleton organization must have been developed. Operation and operating methods depend entirely on the organization which has been built up. A business which is well organized has gained an excellent start toward effective operation. Organization is the foundation of most operating management steps. Proper organization simplifies management in ways which are impossible in a business which is not well organized. Much of the criticism which has been leveled at certain methods of management in particular enterprises should rather be leveled at the faulty organization which existed, and which made impossible the laying of the groundwork on which these methods should have been based. In a profitable business in which the organization is good, if forward-looking steps in management are tried, they usually will succeed with little difficulty.

Ordinarily the poorly constructed organization is typified by executives at the top who are struggling continually with a mass of detail, who point to their terrific tasks, and perhaps feel that they are not able to take a vacation once in five years. The organization which is well constructed is typified by the smooth flow of detail throughout the executive organization and by chief executives whose minds are free to think constructively.

The fundamental power for the operation of a business is provided by its organization. The manner in which routine flows through a business may well be contrasted to the flow of potential power through water-power developments. The poorly constructed organization is like the power plant of the old-fashioned factory on a river from which a portion of the stream is diverted through a canal passing over a single water wheel which turns the machinery of the factory. Organizations of this type provide for action by only one man, and he is enabled to take care of but

a portion of the potential power that flows along the course of the business. The well-constructed organization is like a great power plant that is set up in a dam thrown entirely across a river. Such navigation as is carried on upon the river is taken around the dam by means of a canal. Every ounce of available energy in the river is utilized by diverting the water through a number of turbines, thus utilizing all the potential power of the river and making it possible to place in action one or several generating units as required by the load. Organizations like this provide, by means of alternate power sources in the form of executives in the organization, for the utilization of all potential power. The breakdown of one unit in the organization does not cripple its activities.

Basic considerations in organization. Prior to discussing specific fundamentals of good organization or particular types of organization development, it will be well to think of some broad organization considerations. By organization is meant the structure of the enterprise, especially from the standpoint of the development of the duties and functions of the parts thereof. The purpose of building up an organization is to provide for a daily routine and effective operation of a business or department with a minimum of direction from above. Effective organization, which is the means of securing operating power in a business, if well developed, tends to produce that power very nearly automatically. Organization carries out its purpose by determining the scope and limits of each individual or group of individuals in a business undertaking, together with their relationships and contacts with each other. By a consideration of fundamentals and types of organization, an executive builds up a structure for his business or department which is peculiarly suited to its needs.

Organizations must be developed primarily with regard to peculiar conditions within the business. The application of the fundamentals of organization will differ widely in two different businesses. The size of a business, particularly, has an effect on the way in which the organization develops. Although the differences in structure of a huge business and a small one may not be as great as might be expected at first, nevertheless the duties and functions to be performed, as well as the method of arranging an organization to perform them, will be found to be unlike. This is particularly true because of the large number of co-ordinating functions which are necessary in the development of a structure for a great business enterprise. On the whole, with the small business it is possible to develop essentially the same type of organization as may be developed in the large business, except that the duties of several people in the latter will necessarily have to be combined in the former.

The type of business will be found to affect greatly the development of the organization. Thus it will be found that steel plants, textile mills, paper mills, or refining plants, although they have the same fundamentals

to deal with, will necessarily apply them in different ways. In a manufacturing business, if the product be standard, ordinarily the organization will need to be differently constructed than if the product were diversified. The same amount of business may be handled with fewer chief executives if the product be standard, because it is easier to delegate authority in such businesses. Even the location of a plant may affect the exact way which the organization is constructed. The effect of location on the personnel may demand this.

To build up an effective industrial organization requires proper observance and application of a series of "fundamentals of organization." These fall into two main groups, primary fundamentals and operating fundamentals. The primary fundamentals must be considered by the executive when building up the scheme of organization and prior to giving any considerable attention to the operating fundamentals. The operating fundamentals may be said to be executive in character. They put into effect the concepts of whoever worked out the primary fundamentals. They aid in the application of these primary fundamentals to the business. The primary fundamentals of organization may be thought of as dealing with those phases of management which include policy and organization building. The operating fundamentals may be thought of as dealing almost entirely with the operating phase of management.

The fundamentals of organization. The primary fundamentals are fourfold: first, regard for the aim of the enterprise; second, the establishment of definite lines of supervision; third, the placing of fixed responsibility; and, fourth, regard for the personal equation. The operating fundamentals, which will not be spoken of in detail at this time, are four in number also. They are, first, the development of an adequate system or method in work; second, the establishment of adequate records; third, the laying down of proper operating rules and regulations; and, fourth, the exercise of effective leadership.

The operating fundamentals of organization lay down the groundwork for the third of the major divisions of management—operating the enterprise. The first of the primary fundamentals, regard for the aims of the enterprise, serves to tie the developed organization closely to the determination of major policies, which is the first of the three major divisions of management. Thus, through the construction of an effective organization, major policies are followed in operations.

Regard for the aim of the enterprise—the first of the primary fundamentals. Regard for the aim of the enterprise is most important at the time that the first steps are taken in the building or development of the structure which is to be termed the organization of that enterprise. In no two businesses are the purposes of the management or the conditions of operation entirely alike. It will be easiest to consider this fundamental

of organization by considering businesses of diverse natures wherein it can be seen that the organization structure must necessarily be different in order to meet the several conditions involved. Let us consider the organization which is necessary to take care of the unusual occurrence wherein speed of attainment and not cost is the dominating factor. Such an instance is clearing of a railroad right-of-way after a wreck. All thought of cost is thrown aside and an organization is constructed which, by main force, will have but one end in view, namely, clearing the tracks and letting through the trains at the earliest possible moment. Compare this to the organization which is necessary for the operation of a huge manufacturing plant which is to remain in existence for many years, whose activities are not only numerous but varied and must all be carried on with due relation to each other. It will be seen readily that the organization structure required in the case of the railroad wreck will be far more simple, far more direct, than will the structure which is required to carry on the work of the great manufacturing establishment.

Length of life of the organization and desired speed of results are important factors in the development of its structure. Thus, the organization necessary to construct a number of reviewing stands for a large parade, which will be put up quickly and taken down promptly, may be far simpler than the intricate organization of a construction enterprise which involves the putting up of a huge office building, or hotel, which may be months in course of construction and may involve the interplay of a very large number of skilled trades. It will be possible to discuss this fundamental somewhat more fully after some of the concrete methods of organizing are clearly in mind. It is sufficient to point out at this time that as the purpose or condition under which the enterprise operates changes, the organization must change likewise. In determining the aim of an organization, major plant policies must be carefully thought through.

The establishment of definite lines of supervision. The second of the primary fundamentals of organization, namely, the establishment of definite lines of supervision, lays down the lines of control which are exercised over the personnel of the enterprise. These lines of supervision may be looked upon as lines of authority, as paths along which orders flow. They are also the paths along which information necessary to the execution of particular tasks is communicated.

In laying down the lines of supervision, the organizing executive has two main problems at hand. First, he must determine the type of organization which is to be used. There are a number of rather definite ideas in organization structure and from among these he must choose the one which he feels best fits the organization at hand. These particular types of organization structure are described in Chapter V. Secondly, he must not only determine the general type of his organization, but he must care-

fully develop and mold the outlines of the type as they can be best applied to his particular business enterprise. In developing his definite lines of supervision he will have to give careful attention to the fourth primary fundamental—regard for the personal equation.

A lack of definite lines of authority will result either in an overlapping of duties or in gaps which are not taken care of by the organization as constructed. The gaps or overlaps may be thought of as horizontal on an organization chart as between the lines of authority which have been laid down, as contrasted to vertical gaps or overlaps which will occur if the third of the primary fundamentals, namely, the placing of fixed responsibility, is not adequately handled. Lack of definite lines of authority will result in dissension between whole departments of the organization, and thus personal attention of chief executives must be given to the problems which arise. Members of one department of the organization will fear that their territory has been infringed upon, or they will fear to infringe upon the territory of some other department of the organization.

Definiteness of control through the establishment of lines of supervision implies the idea of tapering authority. It implies the development of a group of executives along this line of supervision, each one down the line having somewhat less authority in scope, and somewhat more direction of detail. The workman who bungles his work in a well-organized enterprise hears from his job boss, not from the president of the company, even though the president may be passing through the workroom at the time that the mistake is being made and even though he may notice the mistake. The job boss, although he has control over the small piece of the business undertaking, similarly is not charged with error in case the undertaking was wrongly conceived and proved to be generally unprofitable.

A substitute for each executive within the organization is essential. This substitute must be available to act in case of illness or enforced absence of the superior, and must be capable of taking over his work in case of death or change of duties of his superior. In the industrial army, as in the fighting army, the company without a head seldom reaches the objective. If there be always a capable substitute, as determined by the lines of supervision which have been developed, it will always be possible to have a head for the shop or the department just as relative ranking always provides a head for the company of infantry. However, if a plan providing substitutes for executives is being developed, it is essential that all members of the organization must have complete confidence in the purpose behind the plan. If they gain the feeling that the plan is merely a club to be held over their heads, so that if they do not prove successful at any time they can easily be removed, the plan will fail. Members of an organization can be shown the legitimate purposes of the

plan. These are, in the first place, that an executive may be always on duty, and, in the second place, to offer opportunity for advancement, either as executives leave or as the business grows.

In small businesses the desire to have a substitute for each executive sometimes has led to a surplus of executives. It is never profitable to carry this idea to the point that additional executives must be put on the payroll. This consideration is often a real one, as, particularly in small businesses, there is often a wide difference in caliber between the executive head of a department and anyone else in that department.

The placing of fixed responsibility. The third fundamental of organization is the placing of fixed responsibility. To place fixed responsibility accurately eliminates vertical gaps or overlaps of responsibility along the lines of supervision which have been laid down. The more responsibility can be given definitely to subordinate executives, the easier it will be to develop substitutes for each executive. The more responsibility for co-operation with other members of the organization is made definitely a portion of the responsibility assigned to the individual member of an organization, the easier it will be to co-ordinate the operation of the various phases in the business.

There are three main results which are achieved through accurately placing responsibility. First, fixed responsibility acts as an incentive to a subordinate. This is particularly true in large organizations. If he knows the field of his responsibility and if he knows that his superior is holding him to it, fixed responsibility in this connection makes possible stimulative encouragement and reward for responsibilities well carried out. Secondly, fixed responsibility aids in the general speed-up of work. It immediately becomes possible to know to whom communications should be addressed or which executives should be called into conference on any particular topic. The breakdown of routine caused by having some important executive cog in the organization unaware of programs which have been laid down or decisions which have been made is thus eliminated. Thirdly, the accurate placing of responsibility assists in developing discipline as a means of control. All good executives utilize discipline to control to a certain extent and, if responsibility is carefully fixed, failure to meet responsibility can be more easily disciplined.

Regard for the personal equation. The fourth of the primary fundamentals of organization is regard for the personal equation. By regard for the personal equation is meant consideration of the abilities and limitations of men and women.

In developing lines of supervision and in fixing responsibility, it is not possible to consider only the factors of the business which would ordinarily demand that decisions of a certain nature be made. It is necessary to take into account the personnel which is available, or which can be made

available. Arranging an organization should be looked upon more as a game like chess and less as a game like checkers. Frequently men have been moved across the board of the industrial game as if they were all of equal value, as if one could readily replace the other, as if one could always fit into an organization niche when another had gone, merely because he was a man of approximately the same salary or had previously performed approximately the same duties. Men are of different values and work together in different ways. They fit into the team-play in various ways. Men are not square pegs or round pegs to be fitted into square holes or round holes, as is frequently said. The concept that a job is of a particular kind and that it is necessary to find a man to fit that job is frequently wrong. It is more frequently necessary to consider the man who is available and then draw the outlines of the job to fit his capabilities.

Merely assigning duties to men does not lead to the accomplishment of tasks and, therefore, it is not possible to draw organization charts and find men to fit them. Some enterprises with branch establishments have organized each branch in exactly the same way, having organization charts for each branch which are exactly the same. It is an outstanding fact that in some of the branches of such organizations it will be found that everything is working smoothly, that everyone co-operates with everyone else; while in other branches jealousies have arisen, dodging responsibilities is prevalent, and the organization seems to be generally ineffective. The difference in the various branches as between mutual help or mutual distrust can be explained partially, in some cases, merely through the personality of the branch manager, but if conditions are carefully investigated, it frequently will be found that there are other causes. The main consideration is that the organization has been outlined, the lines of supervision have been drawn, the responsibilities have been fixed, and the personal equation, the abilities and limitations of the men and women, has not been taken into account.

It will not be possible to enumerate all of the factors which must be considered in giving proper regard to the personal equation as a factor in organization. Merely to mention some of them will direct attention to others. There are several such factors to which attention can be directed deservedly. In the first place, proper consideration must be given at times to thoughts of home and outside worries. It is well enough to say that men or women should leave their social affairs outside of business buildings, but human nature unfortunately frequently does not permit of this. Men whose families may have quarreled over domestic problems, such as the marriage of the son of one to the daughter of another, do not ordinarily make good co-workers. Intelligent executives frequently have had to give consideration to matters of this kind when building up or rebuilding their organizations. Hidden reasons for failure of an organization to work

together are found frequently to be as peculiar as this. Some men are large enough to bury such differences. Most men, particularly sub-executives, are not. Secondly, the habit and inertia of the personnel of an organization must be considered. New organizations are easier to construct than are old organizations to reconstruct, for just this reason. The "efficiency man," who developed so much trouble for himself, frequently did so because he refused to consider habit or inertia of personnel as a reason to warp lines of supervision to meet conditions as he found them.

Operating fundamentals of organization. The operating fundamentals of organization have been previously noted. They are the development of an adequate system, the establishment of adequate records, the laying down of proper operating rules and regulations, and the exercise of effective leadership. These fundamentals, following chronologically the primary fundamentals in their application, put life-blood into the framework made possible by the primary fundamentals.

The development of an adequate system. Considerable confusion frequently develops in the minds of many who speak of organization matters, in that they speak of some of these operating fundamentals, which are so easily observed, as if they themselves wholly comprised organization. This is particularly true of system. The operating fundamentals are concrete in nature, as compared with the more abstract primary fundamentals, and, being easily seen by the casual observer, are easily misunderstood for organization itself. Thus it is not at all unusual to hear such a conversation as the following:

"He certainly has his plant well organized."

"Yes, his system is wonderful."

This clearly indicates a confusion in the minds of the speakers between "organization" and "system."

System is a part of organization, not the whole. As an operating fundamental it helps to bind the whole mechanism of organization together. System is the existence of order and method in all parts of an undertaking. It relieves the man at the head of the details of execution, and is a bulwark that prevents the lines of authority which have been laid down from being overstepped. It brings work to executives with the preliminary steps completed and ready for their attention, thus enabling them to apply their entire time to matters of maximum responsibility. When all factors in a business are moving in a regular and accustomed routine, the waste of time and effort that is involved in repeating the preliminary steps of the solution of any problem is avoided. It is the function of system to provide for this routine, to provide in advance for all detail work, preliminary or consequent. Furthermore, instead of allowing important steps to depend on some man's fallible memory, system, as

through the establishing of a tickler device,¹ makes automatic provision for the initiation of all action necessary to complete the steps.

Although system implies order in work, it does not necessarily imply economy. A procedure may be highly systematic, but still very wasteful. This has caused many highly developed systems to fall into rightful disrepute, but should not cause any attempt to eliminate properly worked out systems.

The "exception principle"—a development of system. System supplies the motive power for what has been termed the "exception principle" of management. When operating under this principle, instead of the head of an enterprise, of a department, or even of only a few men, attempting to act personally on each case coming under his general jurisdiction, he acts on the exceptional matters only. Frequently recurring matters are made routine, a system of checks and balances having been developed in accordance with responsibilities already fixed, so that these matters may be handled entirely without reference to the executive himself. The exception principle demands that the manager receive reports of all portions of the enterprise under his control. These reports are summarized as far as possible, and even these summaries are carefully gone over by the manager's assistant, if he have one, prior to presentation to the manager for his attention. The assistant can make notations of additional information which he may possess on given points. If he sees that some matter in which the executive is particularly interested has not been properly handled, he may return the report to the compiler thereof for further treatment in that regard.

By the operation of the exception principle, all routine matters may be handled by the executive in a few minutes, and thus he is enabled to devote his entire time to the more important matters which should, by right, demand his personal attention. He may give more detailed consideration to the peculiar cases, which do not fall under the routine. In devoting his attention to these cases, he is enabled to work over them to such an extent that he frequently can correlate them and develop the points of similarity and difference in them, until they, too, are classified and no longer may be termed exceptional, but are routine. He is also more free to consider the broader line of policy of the section of the business under his control. There are many cases where departments, or even whole concerns, have come into grave difficulties for no other reason than that an executive so tied himself up with routine matters, due to the absence of proper system, that he failed to notice the general trends occurring in his branch of the business. It will be found generally that the operation of the exception principle, through system, gives fuller oppor-

¹ A means of bringing copies of correspondence, or other papers to attention on a given day.

tunity for the development of the other fundamentals of organization, such as fixed responsibility. The executive is enabled to learn more of the possibilities and capabilities of the various members of his staff, and is thus enabled better to distribute responsibility among them.

System, though tangible when contrasted with the primary fundamentals, is less tangible than the other operating fundamentals of organization. It is not as easily seen as are records, nor as easily read as are rules and regulations. Yet the effect of system is clearly noticeable when it exists. There is, in fact, a condition of management generally known as systematic management, which represents a considerable advance over rule-of-thumb method, and yet which is far from modern scientific management. Systematic management represents a rather full development of system within an organization, without a corresponding development of the more thoughtful processes associated with modern management. In plants where this type of management can be found it will usually be discovered that the executives are methodical in the extreme, and in some departments the smoothness of operation will be extremely high. In systematic management it will be discovered usually that, though considerable attention may have been given to all the fundamentals of organization, the greatest stress has been given to the execution of orders through the development of a complex, but generally effective system. It is in this type of management that the importance of the office clerk and bookkeeper reaches the zenith, as compared to the development of the manager, or thinking guide of the enterprise.

Reports as an aid in developing system. One of the bases of the successful operation of the exception principle, or in fact, of system in general, is the securing of adequate reports from subordinates. A report discharges the responsibility of a subordinate to his chief. It is the completion of a task, the end of an assignment of work to be done. Just as an order should communicate all information necessary for execution, so a report should communicate all information essential to administration.

The prime requisite of a report is that it shall serve some really useful purpose. Many times this fact has been lost sight of by the executive who delights in keeping a "memory book" of the history of his business or department. Such men require the submission of reports which are of slight, if any, practical value. If reports are to be an aid to the operation of the exception principle, this must be avoided. Otherwise a condition will soon arise in which the reports will not be read and will not serve as the basis for action. If a good executive finds reports accumulating on his desk which he does not look at week after week, he should recognize this as a danger signal. The reports in such a case are either inadequate, are being rendered too late for action, or should be discontinued entirely.

The submission of reports is one of the most important functions of the young man who is just entering the field of management, and who secures a minor executive position. The ability of such a man properly to present the subject at hand for the consideration of his chief is one of the most unfailing ways to secure the approbation of the latter. The reason for this is easy to ascertain. The ability to prepare a concise report, which is directly to the point at issue, covers all the necessary facts, and at the same time does not waste space in the inclusion of non-essential details, is the best possible evidence that the subexecutive has an understanding of his work, has completely thought through and analyzed the situations that have confronted him, and that, in short, he has successfully mastered his job and is the type of person to whom more responsibilities may be given.

Reports to executives should be always concise, should give the general facts and general conclusions, if any, in the first few paragraphs, and then should follow these with such elaboration and data as are necessary in the particular case at hand. All information that is susceptible of comparative treatment should be so handled, so that the executive may see trends without having to look up prior reports or other older information.

Reports corollary to the development of system may be written or may be entirely statistical. The development of statistical reports involves the same problems and may be worked out along the same lines as that of written reports. Statistical reports, to be effective in the development of system, must readily call the attention of the executive to the unusual figures, and not draw his attention unduly to figures which may be considered normal.

Organization reports may be periodic or special. Special reports are prepared on some unusual subject by special assignment. Periodic reports are regularly presented at stated intervals. Examples of these are the following: The Analyzed Cost Statement, comparing actual with standard costs (see Chapter XLVII); the Sales Reports, including those presented to the general management by the sales department, and those presented to the head of the sales department by the departmental or territorial chiefs therein (see Chapter XXXVI); and the Factory Production Reports (See Chapters XLIII and XLIV).

The establishment of adequate records. Records, although differing from system, frequently inject into the latter the life-blood which allows it to survive. System without records does not usually prove successful. Records are even more tangible than system. They are definite, and therefore their provision, maintenance, and improvement are more simple than in the case of system. Records give the facts concerning the operation of the enterprise. Their preparation and use make possible the elimination of guesswork from management. They are an operating

fundamental of organization because they are used after the primary fundamentals have been established, and by the organization that has been built up in accordance with the concepts of its primary fundamentals. Records are an instrument used as the basis of action, or at least as the basis of reports on which action is taken.

In the provision of proper records the executive has before him an opportunity equal to almost any other in the field of management. It is easy to get too many records of an unintelligent sort; it is equally easy to provide too few records. The provision of just the right type of records in just sufficient quantity is one of the clearest indications of good organization. Too few records are costly, too many records possibly even more so. Once the idea of the necessity of records is secured by those in charge of the enterprise the immediate danger is the development of "red-tape." "Red-tape" is of three general kinds: first, too many records, including some unnecessary ones and duplicate records made up by different departments; second, too many forms to secure essential information which might be secured on a smaller number by combining several; third, the unnecessary refinement of information. Ordinary processes of manufacture, distribution, or administration may easily be halted while absolutely accurate figures are secured, when approximate information would serve the needs of the executive.

Not the least important phase of record collection is the form on which the record is secured. As previously stated, there should be as few separate forms as is possible. A multiplicity of forms results in their frequent loss, and consequent absence of information that is needed because one of many forms relating to a particular problem is not at hand. Forms should be of standard size wherever possible,² in order that their handling, as well as their filing, may be expedited. They should be constructed so that they are read easily, with the most important information standing out most clearly when the form is filled in. An integral part of "adequate records" is to maintain them physically so that they may be secured when needed.

One maxim with reference to records, as well as other devices of management, is that they are only valuable to the point where the cost of their collection is less than the savings which their collection will effect. Many interesting data can be collected at large cost. If the executive is of the type who likes to know the detail of operations from every possible angle, it is not difficult for him to secure the information. It is likewise not difficult to increase the overhead cost of the business tremendously.

One type of records which usually justifies their cost of collection, however large, if their value be determined in broad rather than in narrow terms, is cost records. Not only must the cost and profits of each article

² E.g., 3×5, 4×6, 5×8, 8×10½ inches, etc.

be shown clearly, but the expenditures and success of each department must be investigated carefully, so that it may be known definitely on which articles profits are being made, and which departments are doing their share in the profit-making on the article, as well as which departments are costing more to operate on the individual process than they should. Proper cost analysis gives invaluable data on conditions demanding reorganization, and on the operation of the organization, as in results achieved through certain responsibility previously placed. The larger and more complex the organization, the greater is the importance of securing accurate costs. As an establishment grows in size and complexity, it becomes increasingly difficult for the man at the top to analyze conditions from observation alone. Conditions of competition and the knowledge of the essentials of careful organization are tending more and more to cut down the difference between cost of production and selling price. To-day rough judgments concerning the cost of production or distribution are fatal. The failure to gauge a business step upon accurate data may result easily in a mistake that will first make profits dwindle and then turn them into a loss.

It is essential that all records, of whatever nature, be compiled so as to indicate trends. Records, like reports, which do not give comparative information frequently are valueless. Certain it is that records which include comparative information are far more valuable than those which do not.

Laying down proper operating rules and regulations. The third of the operating fundamentals of organization, rules and regulations, is the tie that binds together all the other fundamentals. It defines the scope of the application of system to the various portions of the lines of authority which have been built up. It provides methods for the utilization of the records, and in innumerable other ways it functions to knit the organization together into a unified whole. The establishment of exact rules, either verbal or written, permits authority actually to be delegated, and system actually to work, because the superior and the subordinate both have a definite concept of their respective duties and responsibilities. One of the ideals of good organization, namely, the handling of routine without direction from above, is thus provided for by the executive handling a matter only once, then laying down a rule for its future handling, thus making it a part of routine. Written rules and regulations may be general in character, touching only on the broad outlines of business policy, or they may be more detailed in character, taking the form of a "standing order," which may provide the exact method of performance of every task in the business. In developing rules and regulations, care must be taken to insure that they are changed as conditions change, and that they are not so detailed as entirely to eliminate individual initiative and the good effects thereof from the business.

Rules and regulations include proper instruction of the personnel in all the features of the business. Unless written rules are verbally and intelligently interpreted at the time of their promulgation, and the spirit behind them clearly defined, it is likely that too often they will be observed to the letter, when that interpreter of all business regulations—judgment—should be used. Good organization demands judgment on the part of the employees to a greater extent than even poor organization, because with the latter poor judgment is not so glaring a defect. It is therefore essential that in the development of the fundamentals of organization, and in their promulgation through rules and regulations, this be strongly stressed. Further discussion of methods of promulgating rules and regulations will be considered in Chapter VII on "Organization Instructions."

The exercise of effective leadership. The last of the fundamentals of organization is in many ways the most important, and is certainly the most intangible and the most difficult to develop. The exercise of effective leadership provides the lubrication which makes possible the functioning of the organization as a whole. If the organization be regarded once more as a power plant, this time of any nature except a water-power plant, the primary fundamentals may be looked upon as the machinery itself; the other operating fundamentals, except effective leadership, may be looked upon as the fuel; and effective leadership may be looked upon as the lubrication. The more perfectly the organization is developed, in other words, the more intricate the machinery, the more necessary is intelligent executive direction or leadership. Lubrication must be provided when and where needed.

The executive in an organization has two main tasks to perform, organizing and supervising. His organization task, although equally important, is not the one that takes the majority of his working hours. The task of supervision or leadership consumes a majority of his time and consists, in the main, of making decisions and handling the exceptional cases as they arise in a way that will promote the smooth operation of the organization. In carrying on this work, if the executive be capable, he will at the same time provide inspirational leadership for his subordinates. Such leadership will promote co-operation and team-play.

Frequently in developing the responsibilities in his division of the business, an executive can find some one in his organization who has qualities of leadership that can be exercised in a subordinate position. Successful enterprises usually have such men in their organizations. If such a man be properly placed in the organization, the other executives and subordinates will work harder, more whole-heartedly, and in a more sustained manner for the purpose at hand. One of the best examples of this type of leadership that was ever known was to be found in the person

of Mike Murphy, track coach and football trainer at the University of Pennsylvania. Although he was not head coach of the football team but only trainer, candidates for the team would be heard time and time again to say that they were "doing it for Mike" or "backing up Mike." His power to arouse the men's enthusiasm, to get them to co-operate and work as a team, was a fine example of true organizing ability.

There is in organization work a type of individual somewhat different from the leader who may be termed the "strong man," who is frequently very valuable to an organization, at least temporarily. The strong man is a man at or near the top who brushes aside the carefully developed lines of supervision or responsibilities which have been fixed and, through his own dynamic guidance, operates the organization, or a large part of it. Such men are dangerous in long-enduring organizations because, ordinarily, in case they pass on, substitutes cannot be found for them. The attitude of reorganization experts frequently has been that the pet plans and policies of such men have ruined many concerns and that a man who cannot work with the fundamentals of organization has no place in a modern organization. This attitude is, in the main, justified, and yet there are many times when the "strong man" is an important adjunct to a business. In new businesses when policies are being determined, such an autocratic head is often far superior, for purposes of getting an organization going, to a group of individuals without his driving power, even though they may work along theoretically correct lines of authority and responsibility. The combination of strong driving force from the top and well-developed fundamentals of organization through the ranks is one of the best, if not the best, means of effective leadership that can be developed.

Effective leadership implies the prior development of the primary fundamentals of organization. Without these, executive control involves one-man supervision of most of the details of a business with all the attendant difficulties.

Evidences of good leadership are not always apparent. They imply creation, by the executive, of a state of mind in subordinates which allows the executive, by suggestion or by his detailed knowledge of the job, to eliminate difficulties as they arise.

Poor leadership is easily observed and comes to light in the inability of an executive to be rid of the papers which come to him for decision, in the man who makes snap judgments, in the man who shows his ignorance of the relationships of the various phases of the business to his own, or in the man who treads the path of custom. The purpose of an executive's presence is to bring together two links in the chain of organization which, for some reason, have come apart, or to cause two gears in the organization which are clashing to run smoothly.

CHAPTER V

THE DEVELOPMENT OF ORGANIZATION TYPES

THE same fundamentals of organization can be applied in very different ways. These differences in application have brought about the development of rather distinct types of industrial organizations. The development of these types corresponds rather directly with the changes which have come about in American industrial history and which have already been described (Chapter II).

The industrial organization of the first period was usually an organization of the military type,¹ that is, authority flowed directly from the boss to various subexecutives in charge of particular phases of the business, and from them to workers. In the simplest form of this military type of organization, the boss was directly over all of the workers in the organization except certain of the factory workers who might be under a foreman. The following diagram illustrates this:

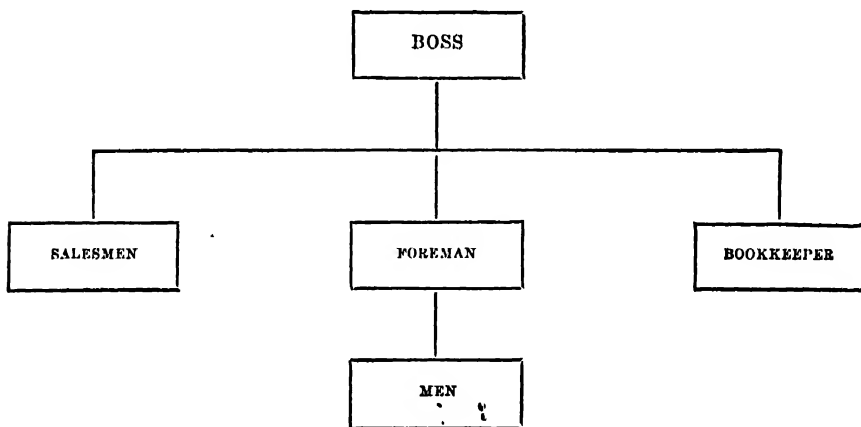


FIG. 1.

The second period of American industry did not bring with it any great change in methods of organization from those of the first period. Such changes as came about merely represented growth in methods utilized during the first period. That is, the military method of organization still

¹ "Military," as used in this chapter, has no connection with methods of organization in the army services to-day. It refers rather to the straight flow of authority within a single combat unit of an army.

continued predominant, and such changes as were made were brought about merely by the growth in the size of businesses, and merely represented a delegation of authority over subordinates on the part of the executives near the top in the business enterprise. This is illustrated in Fig. 2.

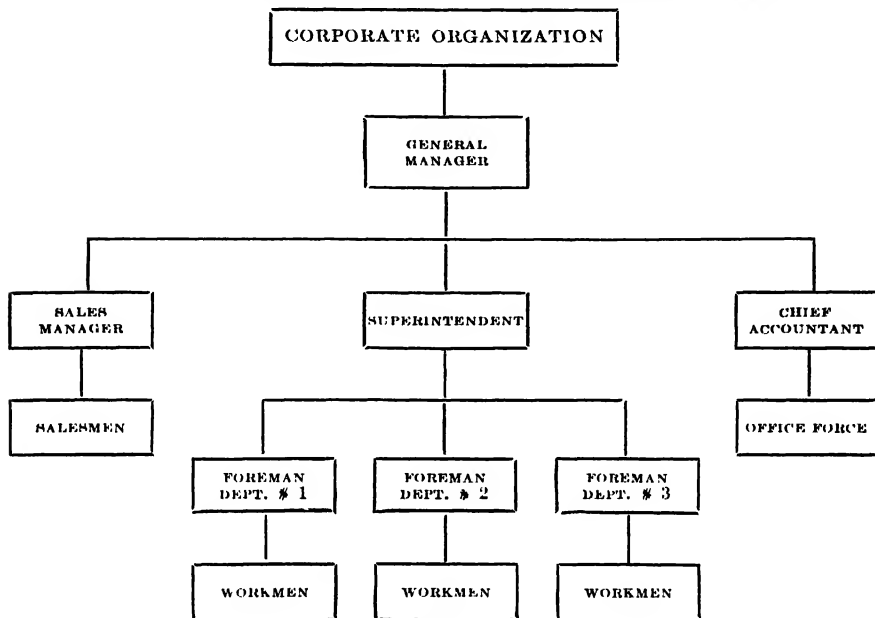


FIG. 2.

The third period in American industry brought with it the development of the functional idea in management and, as an outgrowth of that functional idea, the development of the line and staff or departmental organization of to-day. Functional supervision of workers in productive departments was advocated first by Taylor. His plan replaced the general foreman with four functionalized foremen as follows:

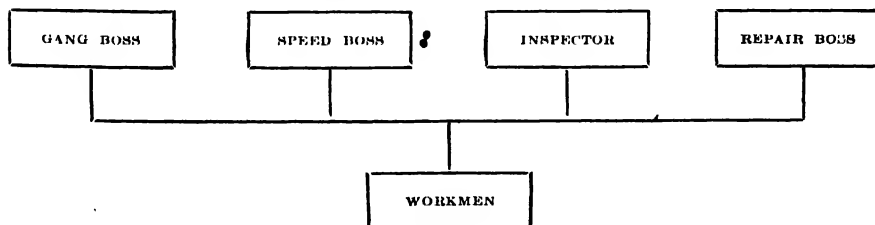


FIG. 3.

In setting forth his plan, Taylor pointed out that "it is because of the difficulty—almost the impossibility—of getting suitable foremen and gang

bosses, more than for any other reason, that we so seldom hear of a miscellaneous machine works starting out on a large scale and meeting much, if any, success for the first few years." He further stated that "this difficulty is not fully realized by the managers of old and well-established companies, since their superintendents and assistants have grown up with the business, and have been gradually worked into and fitted for their especial duties throughout years of training and the process of natural selection. Even in these establishments, however, this difficulty has impressed itself upon the managers so forcibly that most of them have of late years spent thousands of dollars in regrouping their machine tools for the purpose of making their foremanship more effective. The planers have been placed in one group, slotters in another, lathes in another, etc., so as to demand a smaller range of experience and less diversity of knowledge from their respective foremen."²

Despite this effort to meet the situation by regrouping of machines, it nevertheless was found that it was practically impossible for a new establishment to secure suitable superintendents and foremen of the business organized along the lines of the military plan. The regrouping of machines, itself, was a mistake in many plants as the manufacturing process could be better carried on if the machines were laid out as formerly.

Under the military type of organization, the foreman was held responsible for the successful running of the entire shop, and when his duties were measured by the requirements of good management, it became apparent that these requirements were extremely difficult to fulfill under the conditions. The foreman under this system of organization must lay out the work for the whole shop, seeing that each piece of work goes in its proper order to the right machine, that there is a man at the machine to do the job when it gets there, and that he knows just what is to be done and how he is to do it. The foreman must see that the work is done correctly, is not slighted, and is done promptly. Meanwhile he must look well ahead, possibly a month or so, to determine what the demands on his shop will be at that time. He may have to provide more men to do the work, or he may have to endeavor to secure more work for the men to do. The disciplining of the men is entirely up to the foreman, as is all relationship between the firm and the men on the subject of wage, including supervision of timekeeping, fixing or recommending of piece rates or day rates, and the readjustment of these from time to time.

It has been seen that, in order to have good organization, responsibilities must be fixed. That is, each member of an organization must have a clearly defined task, the limits of which are well known. It is evident that there are few limits to the foreman's task under military organization, and that it is unlikely that the task can even be defined. Each day he

² "Shop Management," Frederick W. Taylor, Harper & Bros., p. 93.

must decide, on the basis of his own judgment, just what small part of the mass of duties in front of him it is most important for him to attend to. He does a fraction of the work for which he is responsible, leaving the balance of the work to gang bosses and workmen to do as they may see fit. If it is difficult to get a foreman with the required large range of capabilities necessary to perform all the various tasks, how much more difficult is it to get subordinates who can qualify?

Taylor pointed out that the qualities of a well-rounded man were as follows: "Brains; education; special or technical knowledge; manual dexterity or strength; tact; energy; grit; honesty; judgment or common sense; good health." He felt that three of these qualities could be hired at any time for laborer's wages. If four were added together it was necessary to secure a higher-priced man. The man combining five was hard to find, and the one with six, seven, or eight almost impossible to discover. With this in mind, Taylor enumerated, as follows, the duties which a foreman or gang boss in charge of a group of lathes or planers is called upon to perform under the military system and the knowledge or qualities demanded of him on that basis.³

"First. He must be a good machinist—and this alone calls for years of special training, and limits the choice to a comparatively small class of men.

"Second. He must be able to read drawings readily, and have sufficient imagination to see the work in its finished state clearly before him. This calls for at least a certain amount of brains and education.

"Third. He must plan ahead and see that the right jigs, clamps, and appliances, as well as proper cutting tools, are on hand, and are used to set the work correctly in the machines and cut the metal at the right speed and feed. This calls for ability to concentrate the mind upon a multitude of small details, and take pains with little, uninteresting things.

"Fourth. He must see that each man keeps his machine clean and in good order. This calls for the example of a man who is naturally neat and orderly himself.

"Fifth. He must see that each man turns out work of the proper quality. This calls for the conservative judgment and honesty that are the qualities of a good inspector.

"Sixth. He must see that the men under him work steadily and fast. To accomplish this he should himself be a hustler, a man of energy ready to pitch in and infuse life into his men by working faster than they do, and this quality is rarely combined with the painstaking care, the neatness and the conservative judgment demanded as the third, fourth, and fifth requirements of a gang boss.

"Seventh. He must look ahead over the whole field of work and see

³ "Shop Management," Frederick W. Taylor, Harper & Bros., pp. 96-98.

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³ "Shop Management," Frederick W. Taylor, Harper & Bros., pp. 96-98.

that the parts go to the machines in their proper sequence, and that the right job gets to each machine.

"Eighth. He must, at least in a general way, supervise the time-keeping and fix the piecework rates. Both the seventh and eighth duties call for a certain amount of clerical work and ability, and this class of work is almost always repugnant to the man suited to active executive work, and difficult for him to do; and the rate-fixing alone requires the whole time and careful study of a man especially suited to its minute detail.

"Ninth. He must discipline the men under him, and readjust their wages; and these duties call for judgment, tact, and judicial fairness."

Taylor's enumeration of the duties of a gang boss had a profound influence on the organization of manufacturing departments of American industry. It became clear that a foreman who had all the necessary qualities for his job under military organization should not be foreman, but at least superintendent.

Functional shop supervision. Taylor felt that the solution to the problem lay in functional shop supervision, as outlined in Fig. 3. He felt that functional foremen, each with but one type of task, would need but four or five of the attributes which he had outlined, and that such men could be found. Under functional foremanship, each workman, instead of coming into direct contact with but one supervisor, would receive his orders from a group of specialized supervisors, each of whom performed a particular function. Because of this feature, functional foremanship was never generally adopted, though the development of staff or functional departments to deal with particular phases of the business and to relieve general supervisors of these phases, was a direct outgrowth of the problems of military foremanship. Taylor, in "Shop Management," set down the proper number of functionalized foremen as eight, four of whom were engaged in general planning work, and thus were entirely removed from the shop. These were really not foremen at all, but staff men working in a production-planning office.

The four foremen in the shop were to help the men personally in their work, each boss helping only in his particular function. Several of these bosses came into contact with each man only once or twice a day, and then for only a few minutes, while the others were to be with the men constantly, and help each man frequently. There was no specific group of workmen with the same four bosses over them, but rather a number of workmen, falling into varying groups for supervision purposes, but organized into given departments for production purposes.

The following brief description of the work of the Taylor functional bosses will also serve as a guide to possible division of work between line foremen and staff departments in line-and-staff organizations.

The gang boss has charge of the preparation of all work up to the time

that the piece is set in the machine. It is his duty to follow up the plans of the planning men and to furnish all the jigs, templets, sling chains, and other necessary adjuncts for coming operations. The gang boss must show his men how to set their work in their machines in the quickest time, and see that they do it. He is responsible for the work being accurately and quickly set, and should be not only able but willing to show the men how to set the work in proper time. This man has nothing whatsoever to do with the running of the machines, and his work is completed as regards a particular operation when the work is set up in the machine. Furthermore, if there be a planning department, though he will advise with it, in a sense he will be mainly executing its orders.

The speed boss must see that the proper cutting tools are used for each piece of work, that the cuts are started in the right part of the piece, and that the best speeds and feeds and depth of cut are used. His work begins only after the piece is set up in the machine, and ends when the actual machining ends. The speed boss must not only advise his men how best to do the work, but he must see that they do it in the quickest time, and that they use the proper speeds of the machine and so set their tool that they secure the proper depth of cut. He may be called upon, by the exigencies of a situation, to demonstrate that the work can be done in the specified time, by doing it himself in the presence of his men. The words "speed boss," refer to supervision over proper speed and not to an attempt to "speed up" the workman without regard to his capacities or the time in which the operation should be performed. This boss has recently been termed an "instructor" rather than "speed boss." He is a teacher of method to the men under him, not a slave-driver.

The inspector is the third of the shop bosses, and is responsible for the quality of the work. Both the workman and the speed bosses must see that the completed work is up to specifications in order that it may be passed for quality by the inspector. The inspector can, of course, best qualify for his tasks if he is complete master of the machines himself, and can personally do the work both quickly and well. Under such circumstances his rejections will be taken with better grace by both the workmen and the other bosses in the shop. The inspector always sees that the first piece made up is of the proper standard in dimensions fit, and finish. He also makes further inspection from time to time as the needs of the job may dictate, to see that the standard is maintained. An over-zealous speed boss, in his desire for large output, may allow the workman to impair the quality of the work done by exceeding the tolerance limits, and therefore the inspector becomes the quality man, as contrasted to the speed boss who is a quantity man primarily.

The repair boss is the fourth and last of the shop foremen. The duties of the repair boss include seeing that the workman maintains his machine

and work-place in proper working condition. This includes cleaning the machine, keeping it free from rust and scratches, proper oiling the machine, the preservation of the proper standards which have been set up for the auxiliary equipment pertaining to the machine, such as belts, counter-shafts, and clutches. The maintenance of the cleanliness of the floor around the machine is also under the supervision of the repair boss.⁴

Can a workman serve two masters? There is a very deep-rooted conviction in the minds of many industrial managers that no workman can work under two bosses at the same time, and the idea of functional foremanship had slow growth as contrasted with the other modern management devices on this account. Mr. Wilfred Lewis⁵ has stated, "The old notion that a man cannot serve two masters or take orders from more than one superior is denied by the new philosophy which makes it possible for the workman to have as many bosses as there are functions to be performed. There is no conflict of authority unless the functions overlap, and even such conflict as may arise is salutary and to the interest of the company." Mr. H. K. Hathaway⁶ has similarly pointed out that there is no conflict if one boss says, "Go east," the next, "Take this equipment," and the next, "Proceed at such and such a rate."

Nevertheless, the thought that a workman could not serve two masters prevailed, and to-day functional foremen are not found, but rather functionalized staff departments, working through one foreman. Recent years have witnessed sweeping changes from the military organizations of the nineteenth century. Most of these changes are built around the line-and-staff type of organization, though it is seldom that successful organizations are built without many modifications from the strict line-and-staff type.

Line-and-staff organization. This type of organization joins to the direct "line" flow of authority, provided in the military type, functionalized "staff" departments, which deal with one particular phase of the business. Figure 4 shows a simple development of line and staff in the production and sales departments of a business. Those functions marked "X" are staff.

In the manufacturing division of a business, the functional departments guide and to some extent control the foremen. In their development, it is assumed that the foremen are intelligent, in fact, that they are the backbone of the operating organization of any plant. The organization is so constructed that the foreman can retain his one-man control over the personnel under him, and at the same time can have his direct responsibilities reduced to a point within the range of accomplishment. The foreman's primary duty is leadership, and under this plan of organization he may

⁴ Much of the material in the preceding paragraphs is adapted, by permission, from "Shop Management," by Frederick W. Taylor (Harper & Bros.).

⁵ President, the Tabor Manufacturing Company, Philadelphia.

⁶ General Manager, Schlage Lock Company, San Francisco.

better perform this function. The functionalized staff departments give technical operating information and orders to those in direct charge of the workmen.

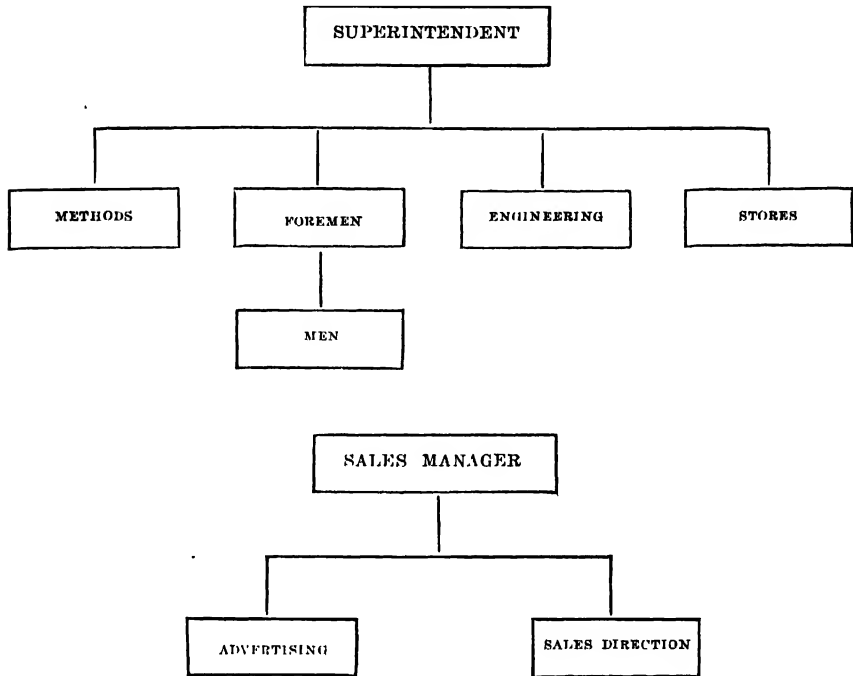


FIG. 4.

In the sales division of a business, the functional departments do not direct the operating or line functions in any way, but perform some specific function, such as advertising, which is of direct assistance to the line members of the organization in better performing their duties. Functional departments have this same position in the financial division also.

The distinction between line and staff members of a complicated organization is not always clear. In any case, in an operating organization, it is more important that the line-and-staff idea be utilized in the set-up of the organization than it is that each individual's duties be clearly line or clearly staff. It is probable that many individuals will have their duties develop so that they will be in some respects line and in some respects staff. However, a line man is usually one whose work controls more than one particular function of the business, and who has workers who are directly productive under him. A staff man usually controls but one function of the business, and workers who are directly productive do not usually report to him. Departments are line or staff, as their heads fit into one or the other of these categories.

CHAPTER VI

ORGANIZATION TO-DAY

THE modern industrial enterprise in which the organization has been consciously and intelligently developed usually is found with a plan of organization that has been molded to fit its own peculiar needs. We have already discovered that it is necessary that an organization be developed with due consideration of certain fundamentals, with due thought to the type that is to be utilized, and with proper consideration of certain features peculiar to the individual business, as, for instance, size, product being manufactured, or even location. Thus, although the basic ideas actuating the organization work of several managers may be similar, each organization ordinarily will be built up to fit the peculiar needs and to approach the particular ideals of those in control of the enterprise. Seldom will it be found that the organization charts of two successful businesses will be the same, although study of them may reveal that the ideas of those developing the organizations were similar. Proper consideration of all factors affecting organization, as, for instance, the aim of the enterprise, consideration of the personnel equation, the size of the business, will demand that the organizations of two different businesses be constructed along divergent lines.

Construction of organizations. In the construction of organizations, most executives now lean to the line-and-staff type, but there are woven in with this other organization ideas, among which are the committee idea, the advisory free-lance, and the usefulness of military organization in those departments wherein fixed responsibility is particularly important.

The development of the committee idea in organization. Proper regard for the fundamentals of organization will enable the executive to lay out the structure, or framework, of an extremely workable organization of the type he desires. However, at best he must paint in these outlines with a broad brush, and there probably will remain many little hidden defects, many places where there will occur friction of one kind or another, due to maladjustment in the various portions of the organization that he has built up. The framework must have built upon it the superstructure of every-day harmony that only can be secured by the whole-hearted support of every portion of the organization that has been outlined. There must be found some lubricant to make the parts of the

organization work with each other and dovetail into one another without the least semblance of friction. Only by reaching such an ideal will there be secured an organization that truly functions smoothly.

Sometimes the necessary smoothness of operation can be secured through the dominant personality of the builder of the organization or his aides in their exercise of leadership. But if the parts of the organization can be gotten to lubricate themselves automatically in their inter-relationships and common business dealings, the strain on the executives, from the general manager to the minor executives, will be relieved to just that extent.

The greatest fault in creating a new, revising an old, or operating a continuing organization has been frequently the failure of the general executives to give proper regard to securing the co-operation of those foremen and minor executives on whom the success or failure of the organization will ultimately depend. Methods must be suited to the circumstances of the particular business or department. The sympathetic support of all must be secured for the proper operation of the organization, particularly if there are any changes to be made in methods of organization, system, or shop processes. The most thorough and effective system in existence will not bring a large degree of success, even if built up on the most perfect observance of the fundamentals of organization, unless it be supported by minor executives and workmen. Thousands of dollars have been wasted by large industrial concerns and small ones in attempting reorganization where this factor has not been taken into account.

The co-operation of the men forming the organization is essential. To enlist the co-operation of these men, who in the last analysis are those on whom the success of operation depends, is, in its larger elements, not a really difficult task. They must have some share in forming the plans, some share in devising the methods of management. They must be made to feel that the methods being utilized are really their own. They must be consulted frequently and thoroughly concerning difficulties, and encouraged to suggest ways of overcoming them. They must be led to tell ahead of time those rocks on which the ship of management is likely to founder, and to point out the shoal waters where it must run slowly. It is their knowledge, their experience, their information about the detail, which must be brought to the aid of the developers of management methods. If some comprehensive plan can be worked out that will insure this result, and if it is put into effect, the difficulties are likely not to appear at all, or to be diminished soon and quickly disappear.

All plans dealing with organization, reorganization, or operation of a business, which are thought out by the heads of the enterprise must necessarily be constructed with these cardinal ideas of co-operation in mind:

The executive must keep in mind this: "What would I think if I were in the other fellow's place? What plans would be most likely to secure my support, develop my latent ability, and bring out the best that is in me for the support of the enterprise?" It is not meant by this that it is necessary in constructing a new organization to keep this idea as the controlling factor in the construction. But this factor must be taken into account and given the weight that it deserves. It is a question of the knowledge, experience, and limitations of the other fellow, and these are vital factors in the success of an organization, for if they are not reckoned with, they are more than likely to limit the success.

The plans must be developed along the lines of complete co-ordination. The fact must be recognized that generally the joint advice of a group of men conversant with a subject is immeasurably superior to the thoughts of one man, or any plan developed from one man's brain. The only possible method of developing a proper group spirit is by getting men together. Their jealousies and their distrust of each other can be eliminated only by bringing them into close contact with one another and by steering them in a tactful manner. The spirit of helping each other for the good of the enterprise can best be brought forth by bringing men together in conference. Perhaps the results will be but gradual, but if proper attention is paid to the methods of cultivation they will be certain and not extremely difficult to secure.

From an administrative standpoint, all persons interested in a given phase of management must have knowledge concerning factors in the business which influence the daily conduct of their jobs. The larger the business the more need for definite co-operation on this point.

A method that has proved of enormous value in attaining these ideals is the use of committees as aids to management. The Committee Idea recognizes the human factor, fosters the spirit of co-operation, implants the new ideas of organization and its fundamentals in the minds of all members of the organization, and gives everyone the necessary contact properly to perform his tasks. The Committee Idea, through organized committees, secures, on troublesome problems, the advice of those best qualified to aid. It stimulates these men to give the company the best that is in them. These standing committees solve routine problems of operation, but also learn of and advise concerning policy and organization development.

Committees are used extensively in organization to-day, and they are largely advisory committees. They usually suggest courses of action to the chairman, aiding him in reaching the decisions for which he is held responsible. He may accept or reject these decisions, but normally, if the committee work is properly developed, matters will be thrashed out there, and the decision will be practically final.

Some attempts have been made to run departments, and indeed whole businesses by the committee method, with a committee, rather than a responsible executive, in charge. Such attempts have at times proved successful in cases where the executives on the committee had had years of experience in working together, and the company was prosperous and not too large. Such ideal conditions, if they exist, do not long last, and most companies that have at times been run by committees have changed the committees to advisory ones in times of stress, or when some dominating member of the committee withdrew from the business.

Formation and duties of committees. In each organization, the problems affecting the men who form the committees would vary so as to make hard-and-fast rules for the organization of these committees very largely out of the question. In most cases the factory superintendent would be chairman of the most important factory committee. Those men in the other phases of the organization who hold similar relationship to their portions of the organization should head their committees. In large enterprises, where the superintendent would naturally have several assistants, these may be the heads of the less important committees, though it has been found in some cases that the work of the committees frequently renders the assistant himself unnecessary. From four to seven men have been found to form the ideal committee in size. A smaller number of men is likely not to provide for sufficient discussion, while a larger number is likely to prove unwieldy.

The advisory free-lance. As business has become more complicated, there have been introduced into organizations persons with duties of a new character. These persons have no administrative authority whatsoever, but are experts in some phase of the operations who report to an executive and advise him on the subject of their specialty. This specialty may be general administration, as in the case of an assistant to the president or an assistant to the general manager; or it may be statistics, finance, budgeting, legal advice, or innumerable other fields. In some cases, as, for instance, in legal advice, the work may be sufficiently heavy to permit the development of a free-lance department instead of an individual. The great advantage of the addition of advisory free-lances to an organization is that they are altogether free of administrative duties, and hence able to devote all of their time to work in the field of their specialty. Phraseology should not cause confusion between an assistant general manager, who carries on part of the administrative duties of the general manager, and an assistant to the general manager, who carries on such free-lance duties as the general manager may direct.

Usefulness of military organization for fixed responsibility. Sometimes the advantages of functionalization and the desirability of creating staff departments have blinded executives to an inherent advantage of

military organization that no other type possesses. This is the absence of all forms of procedures and red-tape in the military type. Given a strong man who is capable of carrying the load, at times when competition is keenest it may be desirable to fix responsibility for a department entirely on one man, and allow him to develop a strictly military type of organization within his department, so that results may be prompt, and responsibility for them may be fixed exactly. Military organizations can have their heads changed more readily, for there is little co-ordination needed within them, since responsibility rests clearly at the top. It is perfectly possible to develop some departments on a line-and-staff basis, and others, where such conditions exist, on a military basis, in order to secure the advantages of both types of organization.

Organization charts. Organizations have their photographs taken through the preparation of organization charts. These set down on paper the structure of the organization, by indicating positions or departments, and then showing the lines of supervision between them, as well as frequently definitely stating under each position or department the responsibilities attaching thereto. As will be seen, organization charts, like other photographs, are not wholly satisfactory, inasmuch as many little details and inter-relationships of live, operating organizations cannot be pictured properly on a chart. But the most satisfactory way of studying modern organization development is through the utilization of a typical organization chart. In studying such a chart it is well to remember that the titles given individuals or departments in various enterprises vary with the whims of the organizer, even though the duties performed be essentially similar. Therefore it is well always to make sure that seemingly great differences between two organizations are not merely differences between the titles of the individuals or departments in question. The attached "typical" chart (Fig. 5), which will be used as a basis of this discussion, will indicate the organization of a large enterprise, because it is in such a concern that the various functions are most clearly separated and defined. It should be clearly understood that in small concerns, although the same functions would exist, many duties would have to be combined.

The typical organization. All organizations have at the top the owner of the business. This may be either an individual, a partnership, or a corporation composed of a group of stockholders. In studying organization, it will be best to consider the most complex of these, and the one most typical of our present economic life, namely, a business owned by stockholders. In such a business the distinction between the corporate or ownership activities and the operating activities is ordinarily clear-cut. The stockholders usually select, through their elected board of directors, a president who is actively engaged in the direction of the corporate pol-

icy of the business. The president supervises all the truly corporate activities of the business, but ordinarily does not supervise the operating activities. In carrying on his work, the president is assisted by duly selected officers, having control of certain parts of the corporate work, such as the treasurer, in charge of company funds and financial policy, and the secretary, in charge of corporate records and stock transfer. The functions of the treasurer and secretary should not be confused with somewhat similar ones incident to the daily operation of the business. In the type of organization being described, these latter functions would be controlled by executives who would be under the control of the general manager, who has charge of and is responsible through the president to the board of directors for the operation of the business. In many smaller concerns, there is no president, but a general manager who reports directly to the board of directors, or the president and general manager may be the same person. In such cases the treasurer is in charge of operating work as well as corporate work. Thus routine accounting and record work would be under the control of the treasurer. It is usual to have the secretary of the company keep only the corporate records, regardless of the organization.

Principal divisions of the enterprise. Under the general manager, or operating head, of the enterprise, there is an immediate split into divisions of operation, functional in form. There is, for instance, the comptroller, who deals with all office, accounting, and record operation; the manager or director of manufacture, who has under his control all matters relating to plant operation and the manufacture of product; the director or manager of distribution, who controls sales; and, in many modern organizations, the director of industrial relations, who deals with all matters concerning personnel. In this development of the main operating organization it will be noted that there are but few main divisions, which means that there are but few persons reporting directly to the general manager. This is an essential of good organization. It gives the general manager an opportunity for real policy development, which he does not have if he has a large number of persons reporting directly to him. A frequent cause of failure of industrial organizations to operate properly lies in having too many persons reporting directly to the general manager.

A necessity which is often overlooked is that of sometimes creating special temporary divisions for carrying on some special or unusual work. Examples of this would be found in the creation of a "new building" division, in case a new structure were being erected for the business, which division would have supervision over construction and movement into the new building, or the creation of a "Government work" division when Government contracts are held by the business. The demands of Government work, for instance, Government accounting, sometimes make

it advisable to erect a complete new division in the organization, if there be much Government work to be done, rather than to subordinate this phase of operation to the director of manufacture or chief of some other principal division of the business.

The plant advisory committee. A tentative personnel for the plant advisory committee would include the designer of product; the head of the sales department, or the member of the production organization whose function is to effect liaison with the sales organization; the head of the cost department; and possibly two or three foremen of the most important departments. There should be a secretary, not only to preserve information concerning actions taken, but to straighten out many difficulties between meetings, and have matters for the committee's attention in such shape that it will be possible to get them out of the way in minimum time at the meetings.

The work of the committee, generally speaking, can well include:

1. Plans to change the product, including a consideration of new methods of design, or new items to be marketed. The interplay of sales and production factors must be considered here.

2. Progress that has been made on changes already begun. This is important, for unless it is considered it will be found that new ideas which have been decided upon and already partially put into effect can be totally forgotten in the press of daily routine.

3. Consideration of methods of cost reduction. Reports by committee members upon economies, decided upon in previous meetings, and assigned to them to put into effect, might be included. In this connection, when work of a specific department is taken up, it is possible and advisable to have the foreman in charge of that department in the committee meeting, whether he be regularly a member of the committee or not.

4. A discussion of routine operation, the status of orders, causes of hold-ups, progress of manufacturing programs, etc.

The number of meetings of this main committee or any other committee are, of course, always to be determined by the needs of the business. However, there probably should be a minimum of one a week, since policy control of each phase of the business should certainly be discussed at least as frequently as that.

The comptroller's division. The comptroller (or treasurer under the second type of organization) has under him certain staff heads, each controlling the operation of one phase of the office work. These men are the office manager, in charge of the general office operation; the credit manager, in charge of the granting of credits and the collection of accounts receivable; the chief accountant; and the chief statistician. A separate section has been set up under the chief accountant to handle costs. This

is a particularly important phase of manufacturing accounting. The collection of cost information is usually regarded as a production function and is placed in the hands of the planning department, under the production manager. In the organization, as outlined, the chief accountant might have one or two clerks who worked on the general books of the business, reporting directly to him. There must of necessity be some tie-up between the distribution division and the credit man under the comptroller. Such a tie-up can well be secured through the committee which advises the comptroller, by placing on the committee a representative of the sales department.

The sales division. The work of the director of distribution falls under several heads, which in large organizations are each in charge of a competent executive. Thus, there are the functions of promotion, including advertising and the development of new markets; sales, and service after sales. The organization of the office of the director of distribution will be found to vary considerably with the selling problems involved in different types of enterprises. For instance, the creation of branch sales houses immediately creates problems concerning the relationship of the heads of these houses, whether they should report through the sales manager, or directly to the director of distribution through a new "branch house section," or possibly report directly to the general manager through a new "branch house division."

The personnel division. The work of the director of personnel has been increased largely both in amount and in responsibility within recent years. Since there will be considerable attention devoted to this phase of industrial organization later, the work of this division will only be briefly outlined at this time. Its functions are clearly indicated upon the chart. In its full development it has jurisdiction over all matters pertaining to the personnel of the organization, be that personnel in the comptroller's office, in the sales department, or in the manufacturing division.

The manufacturing division. Directly under the director of manufacture, or "works manager," as he is frequently known, there is a line man, the superintendent, who, with the aid of advisory committees, directly controls the operations of the foremen of the various departments of the factory. The foremen are directly over the workmen, possibly through job bosses, or assistant foremen, who may be in control of certain portions of their department. There is thus direct line control or authority from the director of manufacture to the workman. It is the establishment of this authority which promotes discipline, and allows for the quick and accurate working of the organization.

The staff portion of the manufacturing organization is to be found partially under the direct supervision of the director of manufacture and partially under the direct supervision of the superintendent. The manu-

facturing division affords the best opportunity to observe the effect of the functional idea in the development of the staff portion of the "line-and-staff" organization. There is, first, the purchasing agent, in charge of the purchasing department. Under older organization types this function was ordinarily placed on an equal plane with that of the chief of manufacture. In modern organizations, he is sometimes found in the same position. Making purchasing a main division of the business may be due to consideration of the personal equation, but it is generally due to the importance of purchasing in the particular business. The purchasing agent, in any business, must be closely in touch with markets and prices, and must be closely associated, in his daily operations, with the sales and financial ends of the enterprise. In some businesses this is not of paramount importance and the purchasing agent can be placed safely in the position shown on the chart. In such cases, policy control with respect to purchases will remain in the hands of the general manager. However, in businesses where much of the profit or loss is dependent on the operations of the purchasing department, it must be looked upon as a main division of the business and a broad-gauged executive placed in charge. Such businesses include those of wide and rapid fluctuations of market price, or those in which the manufacturing operations are relatively simple and do not add greatly to the value of the product, as in cotton mercerizing. When these conditions do not exist, better results are ordinarily secured by placing the purchasing agent as indicated on the chart. Such correlation with other departments as is necessary can be secured through placing him on one or more advisory committees, and still leaving him under the control of the manufacturing manager. The value of placing the purchasing agent under the control of the director of manufacture lies in the possibility thereby secured of correlating his functions with those of the production manager, inspector, and chief engineer, whose duties will next be described. The work of each of these men is bound up closely with the operations of the purchasing agent.

The chief engineer, or head designer, has charge of the design of product and related subjects. He is thus particularly qualified to, and it is necessary that he should, sit on several of the important committees, as his work affects nearly all phases of the business. He is generally a member of the Manufacturing Advisory Committee, and frequently he may be found on the Plant Advisory Committee. It is ordinarily a mistake to make the engineering or design department a separate division of the business, reporting directly to the general manager. This tends to lay too much emphasis on changes of design of product, with the result that both sales and production departments are hampered in their operation. However, there are some businesses, such as clothing manufacture, where the importance of the designer is great, and in such cases consideration

may well be given to whether or not he should head a separate division reporting directly to the general manager.

Under the superintendent in the factory organization are found the members of the staff departments, who deal with particular functions of plant operation. The production manager has charge of those features which deal with aiding smooth flow of production. The chief inspector has charge of quality of production; the safety engineer has charge of the safety work; the plant service manager has charge of those functions which primarily assist the other departments that deal with production to function smoothly. Under the production manager is the planning department, the standards and methods department, the tool department, the power department, and the maintenance department.

Complete discussion of the functions of these various staff production departments will be reserved for consideration at later times, as each department's operation is fully considered. Nevertheless, a brief statement at this time is desirable. The planning department has complete jurisdiction over all the planning functions handled by the foremen under a strictly military organization, and in addition its development has caused the creation of certain new functions, as enumerated. The standards and methods department is interested in developing and explaining how the work should be done, in order that the planning department may have a basis on which to plan, and the foreman on which to direct. It also provides the inspectors with a basis on which to check the work. It is this department which has the most active daily interest in the substitution of science for rule-of-thumb methods in getting out production. The items listed as duties of this department are all portions of this phase of work. The tool department insures that all tools, of whatever character, necessary to production, are ready at the time needed and in proper condition. Thus maintenance of tools is part of the work of the tool department rather than the maintenance department. The power department has charge of the generation and transmission of power throughout the factory. The maintenance department has charge of the maintenance of plant, machinery, and equipment and is the logical outgrowth and development of the "repair boss" under the original scheme of functionalized shop supervision.

The functionalized inspection department, under the chief inspector, is the quality department of the production organization, and although under the superintendent, is distinct from the quantity divisions of the organization as represented by the group under the production manager and the foremen of the various departments. It is exceptionally desirable to have different men working for quantity and quality. At the same time, their work must be correlated under one head. In cases where the product is one with the exceptionally high quality requirements, the inspec-

tion department may not report to the superintendent, but directly to the works manager or director of manufacture. The chief inspector and his department deal with raw materials, and with partly finished and finished product. All quality work which relates to production is under their supervision.

The safety engineer has complete charge of all safety work in the factory, particularly in dangerous trades. His position is one of great importance. As a matter of fact, in the most dangerous trades he might become a man of such importance as to be called director of safety and be one of the men immediately under the general manager. There is also the possibility of the location of this function under the control of the director of personnel.

The plant service manager has charge of the stores department, finished stock department, traffic department, shipping department, and plant transport department. In order to be able to control the planning elements of production, it is essential for the production manager to have close contact with the plant service manager and the operation of the stores department. He must know what material is available for manufacture, so that he may take steps through the purchasing agent to have the necessary material ready at all times. The relations of the production manager's group of departments and particularly the planning department, to the stores department are so close that it logically may be said that stores, and for the same reason, plant transport as well, should be under the production manager. They are to be found there in many plants. The work of the other departments under the plant service manager is self-explanatory, except that it will be noted that the follow-up of purchases shipped and of finished goods shipped is left with this group rather than with the purchasing and sales departments, respectively. Follow-up work of this nature may thus be centralized and correlated with the production program. However, this is an excellent example of the type of work in which the personal equation must be taken into account when developing lines of supervision and fixing responsibilities. Given the proper type of purchasing agent or director of distribution, these tasks might easily be split between them.

Departmental committees. Departmental committees, which correlate the work of particular departments of the concern, would operate along essentially the same lines as the main committee. It is probable that their meetings can be held less frequently. It is very advisable to include on these departmental committees some of the subexecutives, particularly in large organizations. This enables these subexecutives to learn definitely about the fundamental policies of the enterprise and, therefore, to be able better to interpret these policies to the rank and file of the concern. This is an important phase of committee system develop-

ment, inasmuch as misinterpretation of the real policy of the firm is often the underlying cause of many labor disputes. Furthermore, a full understanding of underlying policies of the enterprise makes certain that everyone is pulling together in exactly the same direction.

The development of the committee idea, and particularly the inclusion of the subexecutives in it, undoubtedly has a good effect on the workman and other privates in the organization. The subexecutive's position becomes a more attractive one to strive for, since it is now in on the "management" of the company. Furthermore, it is soon found that under the operation of the committee idea, it is unusual for department heads to pick unfit men for subexecutives. This acts as a further incentive to the worker.

Foremen's meetings. Another phase of the development of the committee idea which has within recent years proved to be of great importance in factory operation has been the "foremen's meeting," held about once a month. It is necessary to guard against having one man at too many meetings in a week, however, lest his time be taken up entirely with the discussion of what he is to do, and what he has done, and he be not given the opportunity really to do anything. At this foremen's meeting there should be present the foremen and assistant foremen, the members of the Plant Advisory Committee, including the superintendent, and if possible, one of the higher officials of the company.

At these meetings operation problems are the main basis of discussion. Employment and general labor matters have also formed an important subject in recent years. Frequently the labor policy of the enterprise can be so shaped at the foremen's meetings as to eliminate danger of labor troubles.

If the departments in a concern are not too numerous, each foreman should make a statement concerning the status of his own department, and a statement as to whether any other department is causing him or his department any difficulty of any character. As the foremen know that they cannot deceive the other foremen before them, each of whom will naturally defend the work of his own department, such a system leads to the discovery of many causes of retarding production. The discussion which ensues leads to definite plans for the overcoming of these difficulties.

The full development of a committee idea, such as has been outlined, insures above all things that the company policy affecting employees, which the general management desires to have carried out, will be carried out. This policy may be warped and changed in the meetings themselves, as the needs which exist are seen, but, once decided on, the policy will be carried through. The fair-minded policy of the management is frequently twisted out of shape, so that the management can hardly recognize it, by the time it reaches the workmen. The committee idea practically insures

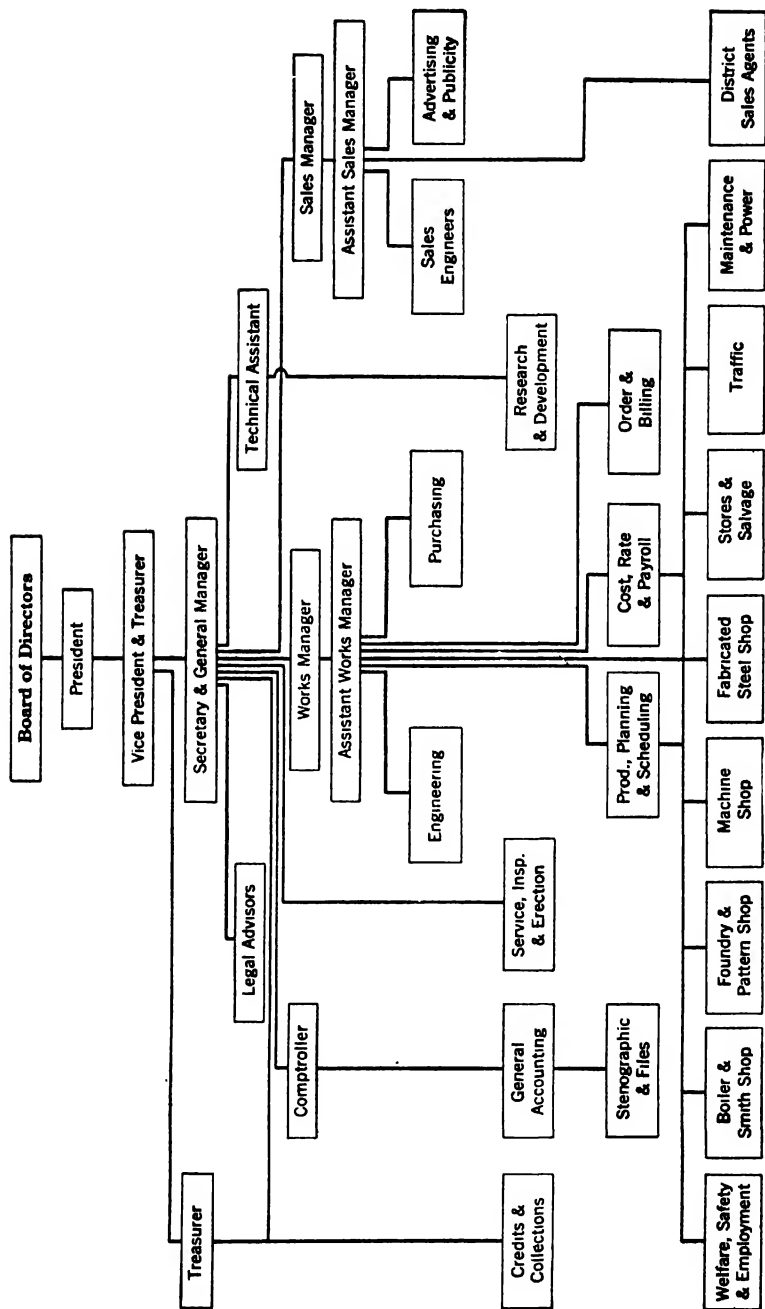
military type of organization there is, nevertheless, some slight functional development under the works manager. It is practically impossible under the competitive conditions existing to-day to run a plant of any size on a strictly military plan. On the other hand, the basic idea of organization may be either military or line-and-staff. In the case of this company it is military.

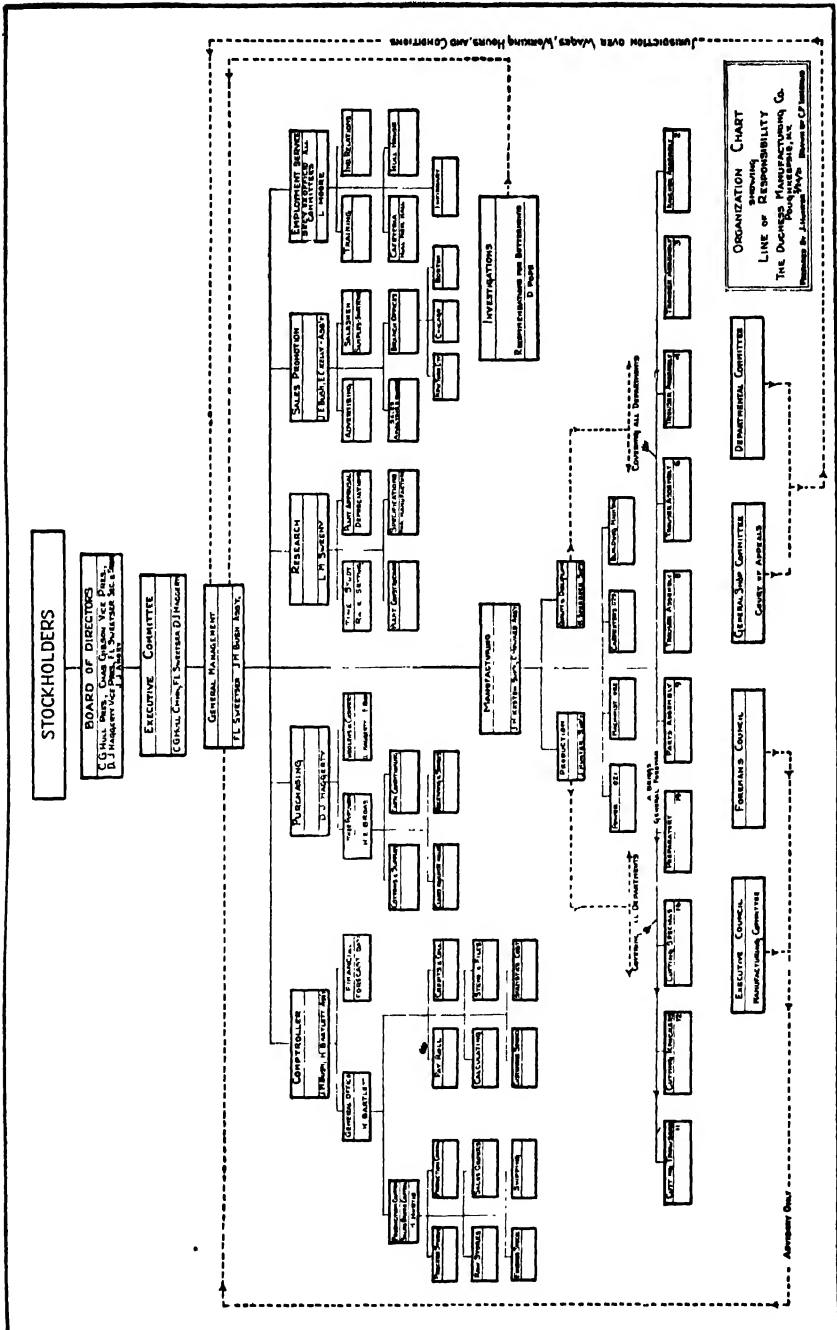
An organization chart of a metal-working company. The organization chart of The Erie Iron Works (Fig. 7) shows the functions necessary in a medium-sized metal-working plant. The emphasis on engineering and research is evident. Placing Service Inspection, and Erection directly under the general manager is effective organization, while the location of costs and payrolls under the works manager instead of under the comptroller indicates the importance placed by the general management on these as factors in control. It will be noted that the assistant works manager has full authority over the manufacturing departments. The legal advisor and the technical assistant to the general manager hold purely advisory positions, and staff divisions are developed throughout the organization.

An organizations chart which illustrates necessary changes with the type of business. The organization chart of the Dutchess Manufacturing Company, of Poughkeepsie, N. Y. (Fig. 8), a clothing factory, is particularly interesting because it indicates clearly the typical changes which can and must be made in the organization structure in the typical organization chart to meet particular operating conditions in a given business. It should be studied from the point of view of changes in major divisions of the business made necessary because of the type of business, and from the standpoint of representation on the chart of functions rather than individuals. Thus, several individuals' names appear several times under different functions of the business. This chart shows extremely well a way of indicating the authority not only of advisory committees, such as have been previously discussed, but of committees having the nature of works councils, which have jurisdiction over wages, working hours, and conditions. As has been previously indicated, in this type of business, purchasing will ordinarily represent a major division of the business and, in this case, research has likewise been made a main division. The separation of quantity and quality under manufacturing should be noticed, as should the position in the organization of the free-lance investigator who makes recommendations for betterments to the general management. The placing of certain specific duties as, for instance, production control, in a far different position from that indicated in the typical organization chart, merely illustrates the necessity for consideration of the personal equation in the building up of an effective working organization.

A home-office organization chart. The organization chart of the

ORGANIZATION CHART OF THE ERIE CITY IRON WORKS





Walworth Manufacturing Company, manufacturers of pipe fitters' and plumbers' supplies (Fig. 9) shows that organization as it was in 1921. Figure 10 is a chart of the home-office organization as it is to-day. Both of these charts show a finely developed home organization for a business operating several plants, sales offices, and branch houses, as well as being engaged in the export trade. Figure 10 illustrates the changes in organization which come about through growth of the business. Although the functions remain the same, additional personnel must be added in execu-

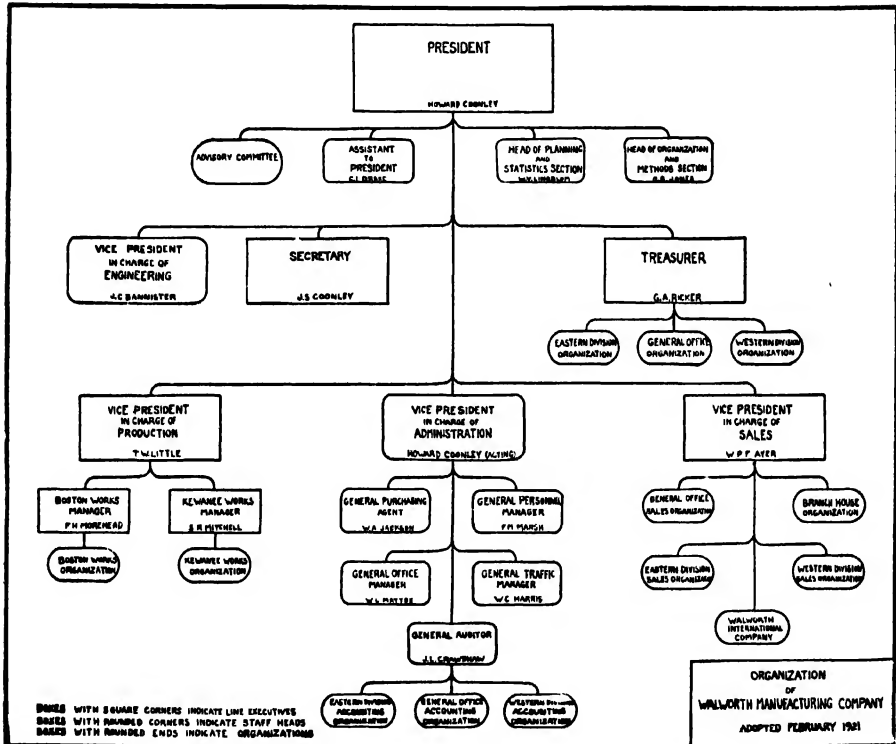


Fig. 9.

tive positions in order to operate the business. The addition of three plants to the two at Boston and Kewanee, noted in Fig. 9, alone is sufficient to account for the changes in organization. The staff functions are shown more clearly in Fig. 9, because the addition of other offices in Fig. 10 has caused these to be grouped on the chart. The same functions are performed in either case. The changes in the organization of sales divisions and branch houses in the two charts should be noted particularly.

Companies without organization charts. Because they feel that organization charts restrict the scope of activities of executives to too great an

extent, some companies refuse to use them. Thus, the vice-president of one large company has said, "At the head of our company is a president, whose duties are, 'No duties at all.' This leaves him free to attend to what may seem proper for him to do. Next to our president, we have a vice-president who acts in the capacity of general manager over all departments. To him report direct the head of each of the departments in the business, namely, sales and service, finances, engineering, purchasing, production and inspection.

Our inspection department reports to nobody in the business except to the general manager or the president and, as a matter of principle, neither of these officials overrules the chief of inspection. This insures a thorough inspection of our product. The one peculiar phase of our organization is that the president is also the sales manager. This is a deliberate point in our organization by means of which the sales department can instantly obtain recognition of any principle it desires without being forced by other departments into a long-drawn-out argument thereon or any other requirements to obtain for sales what the public wants."

CHAPTER VII

ORGANIZATION INSTRUCTIONS

WHEN discussing rules and regulations as an operating fundamental of organization, it was shown that one of the chief methods of presenting these to the personnel of an organization was through the utilization of standard instructions. Standard practice instructions place in black and white developed organization details, and transmit these to all members of the organization who are affected. A standard instruction operates on an organization somewhat as would a ratchet. A degree of perfection is reached, the standard instruction is issued to describe this, and the chance of retrogression is minimized.

The importance of standard practice instructions to an organization will be clearly indicated, if we but think for a moment, of the many achievements of ancient civilization which were lost to the people of the world for centuries because of the absence of means of recording in ancient times. The business that does not record its important organization details in standard form is in much the same position as the ancients. It is just as difficult to retain, within the business, the advances which are made, and the methods of procedure which are developed, unless these are written down, as it was for civilization to retain knowledge of the methods of manufacture of Egyptian bronze or Toledo or Damascus blades.

Some managers have come to feel that one of the best measures of the extent of good management within a concern is the extent to which it uses standard practice instructions. The reasons why such may be the case are evident. We frequently speak of rule-of-thumb management as the opposite of modern management. Under rule-of-thumb management, action can be secured upon a problem only when the occasion arises. This results in thinking of each problem separately, so that such shops have their great body of common practices which have gradually crept in, and which are largely unrelated. Methods are variously understood and variously interpreted by those most affected. The traditions of the past are treasured up in the minds of the oldest employees, who transmit them upon occasion, much in the way that the ancient bards were accustomed to transmit the history of early times.

In the development of standard instructions it is necessary not only to think clearly and to think through the subject of the instruction, but

it is necessary to think ahead. It is evident, therefore, that standard practice instructions within a business indicate a tendency on the part of the executives of that business to think clearly, to think through, and to think ahead.

Uses of standard instructions. The general reason for utilizing standard practice instructions is to give orders through the proper organization channels of the business. They are used to show the scope or lines of authority within the organization, or to describe methods of procedure. A procedure involves the inter-relationship of two or more persons in the business.

To use standard practice instructions to show the scope of authority of each of the members of an organization makes them an interpreter of the organization chart, if there be one. It is impracticable to show on the face of such a chart all of the necessary facts. Consider a manufacturing organization in which the functions of finance, sales, personnel, and manufacturing are segregated, and the persons in charge of these functions are responsible to the general manager. Standard practice instructions define the general responsibilities of these divisions, together with the relation of one to another. They extend to the departments of the divisions, then to minor sections, so that each member of the organization is fully acquainted with his duties and relationships to others in the organization. These standard practice instructions are not necessarily fixed; in fact it is the usual thing to find them under constant revision. Their value is that during the periods of change existing relationships are maintained until they are superseded in written form by new information. The value of standard practice instructions, showing scope or lines of authority, is increased when functions are transferred from one member or department of the organization to another. If they are of value in stating current conditions, they are of greater value in bringing changed conditions to the attention of all within the organization.

Figure 11 is an excellent example, from the Sparks-Withington Company, Jackson, Mich., of standard practice instructions which show scope of authority. The names have been changed from the original.

To describe methods of procedure is the second reason for the preparation of standard practice instructions. Examples of such instructions might include instructions as to the handling of complaints, instructions concerning action to be taken on certain paper work, or instructions concerning the method of estimating the demand for a new article or line to be added to those already manufactured by the company. Such standard instructions clearly indicate the way in which successful management operates. When occasion arises for the development of such instructions, the manager in charge of the function involved sees that the standard instruction is prepared and put into the hands of those who must operate

FIG. 11.

THE SPARKS-WITHINGTON COMPANY**JACKSON, MICHIGAN****Organization Bulletin No. A 21****GENERAL ORGANIZATION**

Effective Wednesday, June 1, 1928, the general organization of The Sparks-Withington Company will be as set forth in this bulletin and organization diagram drawing No. 287 dated May 27, 1928. Detail amplifying more fully the duties of various departments has been covered by bulletins and this bulletin may be changed or amplified from time to time as subsequent organization bulletins are issued by the management.

EXECUTIVE HEAD**MR. WILLIAM BROWN, General Manager**

In general charge of all Company activities; in direct charge of New Products Division, also Sales and Advertising.

PRODUCTION HEAD**MR. W. J. FORBES, Asst. General Manager**

In charge of all matters under General Manager's authority and during absence of General Manager. In direct charge of Planning and Purchasing Division, Service Department, and Welfare Work.

NEW PRODUCTS DIVISION—Mr. T. J. Scofield; Foreman, L. E. Johnson

Experimental work and such special duties as may be assigned to this department by the General Manager.

SALES DEPARTMENT—Mr. H. G. Brown, Jobbers' and Export Sales**Mr. O. M. Brown, Manufacturers' Sales**

Will co-operate with Advertising Department, Service Department, Order Department.

Mr. H. G. Brown will authorize the issuance of shipping orders to the jobbing trade, production of which will have been planned for by general production plans. Special orders to be taken up with the Assistant General Manager for approval before being entered.

Mr. O. M. Brown will pass on orders for shipment of material to manufacturing trade. Will see that complete records are filed from which quotations were made so that estimates and such figures will be available for the cost and methods departments for comparing with production experiences.

FIG. 11.—*Continued.***ADVERTISING DEPARTMENT—Mr. Max Corning, Adv. Mgr.**

In charge of production of all advertising matter and direct such advertising campaigns as may be authorized by the management.

Co-operation with the Sales Department of course is primarily essential.

Co-operate with the Purchasing Department in procuring competitive bids on such advertising matter as may be required.

Act with the Purchasing Agent and Office Manager in procuring general printed matter for factory and office use, of the most satisfactory kind and at the most favorable prices.

ACCOUNTING DIVISION—Mr. H. M. Tilden, Treasurer

Accounting and Costs; responsible for financial matters and for the gathering and recording of costs and results of operations.

Stenographic Department, filing, sales department clerks, purchasing, planning department clerks, factory production clerks, and other clerks on miscellaneous work; authorize the purchasing of office supplies and stationery and office mechanical equipment.

Accounting—Mr. R. Bliss

Costs and Payroll—Mr. M. Bettendorf

Stenographic work—Miss C. Olsen

PLANT OPERATING DIVISION—Mr. H. A. Black, Factory Manager

This division will work in co-operation with the Assistant General Manager on all production matters.

It will co-operate with the Planning and Purchasing Division in completing production schedules in accordance with the orders and quantities required by the Planning division and our customers' requirements.

Engineering Dept.—Geo. White, Chief Engr.

Operating Div.—Mr. Burchard, Superintendent

Mechanical Div.—Mr. Emery

Inspection Div.—Mr. Poor

Methods Div.—Mr. Carney

Transport Div.—Mr. Blanchard

Mr. White is chairman of the Operating Division Committee.

The head of the Inspection Department will co-operate closely with Assistant Factory Manager in the matter of inspection and maintenance of quality standards.

under it. Once this is prepared, the matter does not come again to the executive's attention, except when a change in the instruction becomes necessary.

Figure 12 indicates an effective way in which a procedure may be visualized through the use of a chart form of standard practice instruction.

Preparation of standard practice instructions. Standard practice instructions may be prepared and transmitted individually, or as a whole procedure or "standing order." If they consist of a series of consecutively numbered memoranda they may be given any name which fits the individual circumstances and the desires of the executives. Among the titles ordinarily given such memoranda are, "administrative orders," "methods bulletins," "organization bulletins," and "production circulars." The signature of such instructions varies usually with the group

	PURCHASING DEPT.			VENDOR	STOREROOM		Inspector	ACCOUNTING DEPT.		
	Order Man	P. A.	File		Receiver	Stores Clerk		Desk # 7	Desk # 8	File
FORM P 7 PURCHASE ORDER	<input type="checkbox"/>	<input type="checkbox"/>		●						
	<input type="checkbox"/>				●					
	<input type="checkbox"/>							<input type="checkbox"/>	<input type="checkbox"/>	●
	<input type="checkbox"/>		●					<input type="checkbox"/>		
	<input type="checkbox"/>		●							
FORM S 6 NOTICE OF ARRIVAL					<input type="checkbox"/>		●			
	<input type="checkbox"/>		●		<input type="checkbox"/>					
					<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	●
FORM N 4 INSPECTION REPORT	<input type="checkbox"/>		●				<input type="checkbox"/>			
							<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	●

ROUTING OF PAPERS - PURCHASE ORDER PROCEDURE

☐ - Originates ☐ - Action to be taken ● - Action completed

FIG. 12.—A Procedure Chart.

that they are intended to affect. Sometimes they are issued without signature when all instructions emanate from the same source. Ordinarily, in order to give full authority to the instructions, they are issued over the signature of the general manager, in those cases in which more than one division of the organization is affected. They are frequently issued over the signature of the division head when the instruction applies specifically to a particular division, but even in such cases they are often countersigned by the general manager.

Advantages of standard instructions. Standard practice instructions are advantageous and vitalize the development of the organization fundamentals within a business because (1) they are not likely to be mis-

understood, (2) they are less likely to be forgotten, (3) they fix responsibility for mistakes, (4) they clarify the ideas of those giving the orders and thus insure careful thought, (5) they make for change in method that is continuously forward, (6) they expedite the routine to be followed by members of the organization, (7) they constitute a ready-reference file of executive decisions. It should be noted carefully that their existence does not necessarily imply that the contents of all orders must be memorized, but rather that the individuals whom they affect may use them for ready reference when in doubt or when questions of procedure arise. On the other hand, the orders most frequently utilized are likely to be kept in mind by all employees affected.

Why standard practice instructions sometimes fail. Standard practice instructions have frequently failed in operation. Their failure can usually be ascribed to one of several causes. These are (1) too many orders, (2) not enough care in preparation, and (3) the preparation of the instructions is sometimes delegated too far down in the organization.

Too many orders may be the result of one or two difficulties--either orders issued from too many sources or too large a number of orders. Much difficulty has been caused at times with the development of standard instruction procedures because orders within an organization have been issued from two or more persons. This does not imply that the general manager and the head of the division may not both issue orders, but the scope of their orders should be carefully defined with reference to each other. The difficulty comes when two people begin issuing orders on the same class of details or procedures. There is nothing which will break down the force of standard instructions more than to have two conflicting instructions, both supposed to be binding. The effect of too large a number of orders is almost equally as bad. An order which is numbered, for instance, 546, is likely to be regarded lightly. The impossibility of keeping such a mass of instructions in mind is clearly evident to everyone. If it is necessary to revise order No. 36, it is desirable to call it order 36-A merely for the effect on the persons concerned. In general, people resent being ruled, and the fewer orders and rules, the better the reaction. Standing orders should be gotten up only when necessary, and to issue them too frequently makes them lose much of their force.

The second chief reason for failure that must be guarded against when preparing standard practice instructions is the failure to utilize sufficient care in preparation. An instruction should never be issued until it is certain that further consideration would not aid in bettering the working of the provisions made. Companies have abandoned at times the use of standard instructions after their use has once been adopted. Failure to guard against this danger is the most frequent cause of such action. Lack of care in preparation may include either the use of terminology that is not

clear or failure to visualize all the implications involved in the order being transmitted. Terminology may be clarified ordinarily by either the issuance of a special bulletin on that subject or by proper explanation at the beginning of each bulletin. It is from failure to give full thought to all implications of the order that more important difficulties arise.

An order which is hastily prepared and issued usually needs amendment. Many amendments will promptly break down a system of standard practice instructions. Some cases have occurred where those in charge of issuing the orders have come to the point of relying on criticism of the order after it is issued as the basis of the real thought devoted to the subject. This plan is based on the general hypothesis that amendments will be necessary anyhow—so why think twice? Soon everyone in the organization gets the idea that all orders will soon be amended anyhow—so why obey them? They begin to have amendments of their own adopted if they do not like the order. Trouble then reaches its zenith. To be of value, the standard instructions therefore must be not only explicit, but correct when first issued. The development of the committee idea in management can be of great aid in the formulation of standard instructions. If department heads are thus consulted and the subject discussed from every point of view within the group affected, there will be no complaint, and few amendments, and ordinarily the system will prove highly successful. All of the advantages of utilizing committees come into particular prominence in this development.

The third reason for failure of standard practice instructions is that some person too far down in the organization scale is delegated to prepare them. This defeats much of the purpose of standard instructions, which is to insure at all times chief executive direction, together with the operation of the exception principle. If a subordinate be delegated to prepare the instructions, the subordinate is actually running the department, if the instructions are observed. However, such a condition frequently results in a large number of amendments by the chief. It is often the cause of the issuance of too many orders, since all interested viewpoints have not been taken into account in the first instance.

CHAPTER VIII

MORALE-BUILDING VS. MORALE-DESTROYING ORGANIZATION

THE executives of a large manufacturing establishment that must be nameless were recently astounded when, at a supervisors' meeting at the works, the general manager announced a complete change in the policy of organization development which had been progressing gradually. The general manager, who had been constructing carefully what he had termed a modern organization, called this meeting for the specific purpose of stating that he felt that much of the organization work which had been done under his direction was bad, and that shortly he would make an announcement concerning a return to the older plans which he had so criticized at previous meetings. Speculation immediately became rife as to the cause of the change of heart. The secret lay in something none of the executives could have ever known—in a trolley-car conversation that the general manager had overheard not many days before. It was between two of these same executives, but not intended for all the ears that heard it. It ran about as follows:

First man: "Well, I see there's another organization chart out to-day. Old Crawford is getting as bad as the evening papers in putting out editions."

Second man: "And that's not the worst of it. Every time a new one comes along, it has a bunch of new lines on it. They're getting to look like cobwebs."

First man: "Yes, and what's more, every new line means something more that can't be done or must be done. It's getting so that the only two respectable English words I know are 'must' and 'can't'."

Second man: "Well, anyhow, we are organized."

Mr. Crawford had thought quite a lot about that little conversation. It had worried him, and he began to sense that possibly, in trying to create a smooth, well-oiled machine to run the business, he had not considered as a factor the loss of much of the enthusiasm, much of the support of his subordinates. His resulting action, as it should not have done, went to the other extreme. But he began to perceive, as other executives have perceived, that in organization development it is necessary carefully to analyze all steps in order that they may lead in the direction of a morale-building organization rather than toward a morale-destroying one. Care-

fully developed organizations that are morale-builders succeed. Carefully developed organizations that are morale-destroyers fail.

A morale-building organization utilizes fully the skill, initiative, judgment, and training of its members, and through such utilization succeeds in building up these and other qualities in everyone, so that the abilities of all constantly expand, and the organization thus is able to succeed and grow. All members of the organization are encouraged constantly to assume greater responsibilities. Thus all executives become accustomed to think of the duties, responsibilities, and difficulties of their co-workers, with the usual result of co-ordinate action and growth in capacity of the individual. As such businesses grow, and they generally do, opportunities for the fulfillment of the aspirations of their members are afforded.

In morale-destroying organizations, restriction of the individual is the keynote. The organizer generally has hoped to make his careful development of organization fundamentals so perfect that unusual, as well as usual or routine, matters will be taken care of promptly and properly in a routine way. The organizer has endeavored to impress his will on the daily actions and relations of all members of the enterprise throughout the business days to come. Into such organizations individuals enter full of enthusiasm, full of a desire to make their tasks and themselves grow, and, through them, the business. It is not long before they become aware of the restrictions that have been imposed, before they learn that the energy they are utilizing in the performance of their tasks is not needed or is not appreciated. They endeavor to utilize some initiative in their daily operations; they find they are hindered by lack of authority. They try to temper their decisions with judgment; they find it is not accepted or is hampered by supervising judgments. They strive for quick action on important matters; they find this is impossible because of the minute balancing of responsibilities. They hope for promotion and greater responsibilities by adherence to their task; they find that this is merely looked upon as making them more valuable in their particular niche, or is disregarded as promotion is made on almost any basis except fulfillment of duties assigned. The result of such conditions is uniform. If the subordinate be worthwhile, if he has sufficient strength of character, and if personal problems do not prohibit, he resigns. If he remains with the business both his character and his ability decrease and deteriorate until he is no longer worthwhile.

In modern industry, it is not only the executives, but also the privates who must have an organization sense. Ability to work together is one of the outstanding requirements for many industrial workers. Therefore organization must be developed to build up, not destroy the ability of its privates to work together. Organizations cannot be built up through the executives only. Loyalty is one of the finest attributes of any member of

an organization, but a management must deserve loyalty before it will receive it. Managements that restrict, rather than build up, the morale of their working force will get little loyalty from the heart, though they will receive much lip-service.

The line of demarkation between morale-building and morale-destroying organizations cannot be drawn definitely. Conditions which place particular organizations in either category do not develop overnight; and even if it is appreciated that tendencies toward morale-destruction are present, it is difficult to determine when they should be encouraged, as tending toward good organization, and when they should be eliminated, as apt to bring over-organization. For morale-destroying organizations are generally cases of over-organization, although under-organization may also be morale-destroying. The very elements which make for morale-destruction, if applied in proper quantities, make for morale-building. An example of this is the proper fixing of responsibility. This fine line of demarkation is used frequently as the excuse for failing to make any attempt to organize. Executives, whose only reason for not developing real organization in their phase of the business is lack of ability or laziness, will point with horror to the dire results of over-organization that have occurred, as if they were common results of any intelligent attempt at organization work.

Conditions that bring morale-destruction. Since there is such close resemblance between well-developed organizations and morale-destroyers particularly in their formative periods, it is necessary that there be considered some means of determining what conditions are likely to bring with them the baneful results. But these conditions, to a certain extent, are essential for good organization development and there are no definite rules which can be used as a guide in keeping away from the dangers of over-organization. There are only certain dangers which must be kept in mind, and all factors must be investigated thoroughly if they appear to be of importance. Evidences of the appearance of any of these dangers should be sufficient to cause a manager to pause and ponder, intelligently to question whether he be developing better organization or whether he merely be restricting the activities of subordinates. The most important of these dangers are: too fine division of authority or responsibilities; too many supervisors; improper selection of personnel for new or expanded duties; over-reliance on organization charts; and too few real executives. Any of these conditions is likely to arise in the course of intelligent, well-developed organization work, and their effect must be kept in mind constantly, when considering the fundamentals of organization and other factors which are likely to cause them to appear. If the organizer can strike a proper balance between these factors, which at times may seem

opposed, he will have developed an organization that will really function and is capable of growth.

Too fine division of authority or responsibilities. Too fine division of authority or responsibilities is likely to result if careful thought has been given to differentiation between activities that must be carried on. Although division of authority and responsibility is an essential, this must not be carried to a point that will preclude original thinking on the part of subexecutives. The development of cogs in a machine, rather than thinkers, must be guarded against. This does not mean necessarily that responsibilities may not be divided finely, or that those entrusted with responsibilities may not receive the expert advice of others along particular lines of work, in order that best-known practice may be adhered to. However, it does mean that initiative along the particular line in which he is engaged must be left each executive, in order that he may take pride in the accomplishment of some definite phase of the work, however small. A long train of conditions inimical to successful operation will be started if initiative be denied subexecutives. It will result ordinarily in the development of organization cogs who may be mechanically excellent in performing daily duties, but totally unfit to meet emergencies, or to take higher positions, which from any cause may become vacant.

Effective leadership is half of an executive's job. It cannot be expected to flourish where individual growth has been prevented. Good executives will not tolerate such restrictions, and will seek other connections. Poor executives constantly become poorer, as they rely always on instructions from above. This last condition forces the management constantly to bring in higher executives from the outside. The final result is that confidence in the business is lost by those on whom its success largely depends, the subexecutives in direct charge of operations.

An example of what to do, rather than what not to do, will best illustrate this point. This is to be found in the correspondence division of a large manufacturing plant in the Middle West that operates many agencies. Here lines of supervision and fixed responsibilities, as definite as any known, have been developed, and yet this has been handled in such a way that each member of the division has been given some work to do which involves originality and the free play of initiative. This condition has been combined with the task idea so that each correspondent has her own complete job to perform. Instead of all correspondence going through supervisors who indicate what the answers are to be, or who dictate them, work is divided among the various persons in the division so that each one receives a certain type of communication and acts upon it. Of course, rules of action are rather complete, but there is much possibility for interpretation of the rule as applied to an individual case. The greatest gain is that each

person has her complete job, with the incoming correspondence as the raw material, and the letter which she writes as the finished product. Instead of a condition which might easily have developed in such a department, where everybody in a huge room felt that she was merely a cog in a great machine, a state of mind has been built up where each person feels that she has a definite, vital part to perform in the continued success and growth of the company. A whole department has been made into a group of sub-executives who have a feeling of confidence in themselves and in the company, and who are able to smooth out unusual situations as they arise, as well as being able to advance to higher positions as they are open.

Too many supervisors. The second danger, which in some phases is very similar to the first, is that of too many supervisors. Such a situation results in conflicts of authority, and failure of the business to progress as might be expected, because of the lack of the push which only can be secured by direct, military supervision. The more carefully organized the concern may be, the more is the chance for this development. The manager or organizer sees a function which is not being performed, and thereupon creates a department or delegates an individual with the responsibility for the performance of this function. If the attention of the organizer be directed to the creation of his technically correct organization, rather than to the cost of supervision or to the driving push so frequently necessary, this condition is particularly apt to arise.

Many executives are fearful lest they run up "non-productive labor costs" to too high a figure. This fear is groundless, providing the costs may be made to repay themselves, but is very real if functions be developed which cost more to operate than they return in cost-reduction. Much of the confusion incident to this situation arises from the use of the term "non-productive" to describe overhead or supervisory functions. This accounting term has often been changed in recent years to "indirect" or "overhead labor costs," and the change has eliminated much of the confusion. From a management standpoint, labor is non-productive only if it does not return to the business more in savings than it costs. There can be no objection to doubling or tripling the indirect labor cost, if by so doing direct costs may be reduced so as to decrease the unit cost of the articles being manufactured or sold. The inherent fear that many executives have of running up supervisory costs results in scanning pay-rolls to see if the aggregate of such costs cannot be reduced, without regard to the savings effected by the supervisors in question. This is not only groundless, but has the effect of throttling intelligent organization development. On the other hand, there is a very definite danger of allowing functions to be created, merely because they seem to be different, and without an adequate check being provided to see that they are or can be made to be paying investments. There is a very real danger of develop-

ing a situation where "for everyone doing productive work there is another man standing over him to see that he does it." The development of too many supervisors in an organization leaves most of them without sufficient real work to do or responsibilities to perform, with the result that they begin to get jealous of having their spheres encroached upon by others, and everyone begins watching everyone else, instead of pulling together to put programs through and intelligently to direct productive effort. It is such conditions which permit of the many profit-making sweeping eliminations of supervisory forces that are used by other managers as excuses for not building up normal, necessary, functionalized departments.

Improper selection of personnel. The third danger lies in the improper selection of personnel for new or expanded duties. Organizations, otherwise letter-perfect, have failed to function because of improper action in this regard. What frequently seems the easiest and best method of handling this personnel situation is to create a function and then seek a new person with the qualifications desired, if such a person is not easily found within the organization. Such is usually the procedure when a cut-and-dried organization chart is used, as when several branch houses are organized on the same basis. One difficulty with such practice has already been pointed out under "Regard for the Personal Equation" as a fundamental of organization. It is difficult, under any circumstances, to find the person with the exact qualifications desired, but another difficulty is the effect of this practice on others who have been long with the company. Only under most unusual circumstances should duties be outlined which clearly will necessitate the bringing in of new personnel over old, unless another grouping of duties which would allow the utilization of the old personnel is clearly out of the question. Maintenance of morale demands attention to this point.

Conversely, it is essential that mere seniority within the organization shall not be allowed to govern organization development. Education and the intelligence levels of the persons concerned must be considered. It is true that in large organizations some orderly arrangement of promotion with length of service as a factor must be worked out, or the effect will be the same as bringing in new people for positions near the top of the organization; nevertheless seniority cannot be made the sole or even the most important basis of promotion. If it is seen that length of service clearly outweighs value of service in reassignment of duties or in filling vacancies, the direct effect will be a let-down of effort among those subexecutives on whom the success of the enterprise most depends—those near the bottom of the ladder. The deadening effect of the application of the seniority rule can be found in the listlessness displayed by subexecutives and clerks in the offices of certain large railroad companies, whose promotion or organization

development policy is based solely on seniority. Listlessness and clock-watching have become the rule of the day, and no amount of reorganization work seems to bring the personnel above the mere level of average, position-retaining performance. Thus it is clear that the manager, in building organizations, must consider his new or expanded duties in the light of two almost opposite reactions of his personnel, the aversion to the newcomer, and the necessity for—and, at the same time, the impossibility of—following the seniority principle. The effective organization is the one in which the tortuous channel around and between these conditions has been followed with success.

Over-reliance on organization charts. The fourth danger lies in over-reliance on organization charts. Properly used, these may be effective morale-builders; but improperly used, particularly if they become the keynote of operation, they are morale-destroyers. An organization chart is not an organization, but merely a picture of it. The pulsating, co-ordinating activities of organizations can no more be shown in organization charts than can the tang of the mountain air and the stimulating effect of the mountain breeze be shown in a picture of a mountain region. Organization charts serve as guides in organization development, but cannot be looked upon as the result of the development itself. There are a number of reasons for this, which will serve to show the field of usefulness of the chart.

If the organization chart is looked upon as recording all the lines of supervision and all the responsibilities which have been placed, it will soon be found that its influence is too restricting. It tends to make the limitations on the duties of the various individuals too stringent and begets the attitude that anything which does not pertain to the particular department or section is no concern of the persons within that unit of the business. Such an attitude prohibits analysis of the work of others and therefore eliminates that necessary co-ordination which follows a knowledge of the other man's difficulties. Even if responsibilities are stated rather definitely under each main department or section, and attention is called here to the main lines of co-ordination, those most important co-ordinating activities of good executives which they take upon themselves in the daily conduct of their tasks cannot be shown adequately. This calls attention to the second main failure of the charts.

Frequently, since the greatest ability of particular members cannot be depicted adequately, the chart seems out of balance and causes the whole organization to question it. It has been shown that leadership frequently is made effective through some person rather far down in the organization scale. Divisions or departments of the business may be built around the personal qualities and trouble-smoothing abilities of this person. And yet such abilities are not picturable. If the organization chart be

looked upon as more than a guide, this man's ability to lead and co-ordinate actually may be throttled. Thus, the free-lance assistant to the general manager who can eliminate much friction as it is about to get started, has duties which it is most difficult to portray satisfactorily on a chart.

Again, organization charts lack the flexibility which most growing organizations need. Emergencies arise daily which necessitate the reassignment of duties. Only by drawing up a new organization chart can these changes be shown. If the changes are made too frequently, the charts fall into disrepute, and if not made, either the charts are behind the organization changes, or the changes are not made when they should be. This can in a measure be prevented, by indicating clearly that certain alignments or duties are temporary, when a chart is prepared, rather than by making the organization outlines seem at least semi-permanent. Similarly, it is clear that, in reorganizing, it is frequently undesirable to indicate to line members of an organization that specialists are encroaching upon their functions until this is an accomplished fact. Responsibilities must be changed or taken away with the greatest amount of tact and painstaking care, and changes must be "sold" to the whole organization. This cannot be done if an organization chart is prepared on which there is emblazoned, so that the whole business may see it, the change of functions. As development work goes on, the "before and after" comparison is frequently made too easy, if organization charts are prepared each time responsibilities are changed.

These objections and inherent defects of organization charts do not demand that the charts be eliminated, though some executives have come rather definitely to that conclusion. They do demand, however, that charts be utilized with care, and with these considerations in mind. They demand that in developing organizations, charts be regarded more as a guide to those who are doing the developing, than as a standing order to all within the business, telling each of them their authority and responsibility. Charts frequently may be made more workable, and these objections may be overcome, if supplemented by standard practice instructions; but of themselves, they can never be regulations for organization operation.

Too few real executives. The fifth danger of morale-destroying organization is relying on too few real executives, that is, relying in most phases of the business on the clerical type of individual as a supervisor with a few real executives holding the guiding reins. This condition is often the result of too fine division of responsibilities, but has equal importance and different results. Heads of departments or sections must be real executives. They must be able not only to control and supervise, but also to inspire the men and women under them to better and greater activity. Since no organization can be developed that does not need the lubricating action of

executive control, it follows that men of real executive caliber are needed for effective operation. They must be able to sense dangers of morale-destruction within their own departments and therefore must be men who have the ability to lead as well as the ability to carry out orders or carry on functions. Organizers who think consciously of subordinate positions as being chief-clerkships rather than subordinate executive tasks are generally creating a flimsy structure which will not survive in time of business storm. Like other structures, organizations must be built to survive the maximum strain which may be placed upon them. In the ability and action of the executives throughout the organization lies the factor of safety. If provision has not been made for this factor of safety, the structure may collapse under the strain of unusual pressure.

The worth of any organization is determined in times of business stress, not in times of smooth sailing under favorable winds. Attention to elementary phases of organization work, such as proper development in the light of the fundamentals, and in the light of conditions peculiar to the business, should provide a structure which will survive in smooth seas. It may not have the morale-building features that will enable it to survive when business conditions demand close harmony, initiative, and judgment on the part of every single person in the enterprise, in order that every slight advantage may be pressed and in order that real economies may be effected. It is such organizations that must, in times of stress, temporarily dispense with many of the key men for temporary payroll gain but for ultimate business loss. Adequate attention to the dangers of morale-destroying organization should enable the organizer so to build his structure that it will be morale-building and can survive any stress, can advance while other businesses are fighting for their existence, and can thus endure not only as a going but as a growing concern.

PART III

THE PLANT AND WORKING CONDITIONS

CHAPTER IX

PLANT LOCATION

ORGANIZATION work has been seen to be a basic management step. But organizations must be given tools with which to work, and the most important of these tools is the factory building. The modern factory building is as distinct from its predecessor as is the modern organization from the former military type. Plants with new and modern buildings have operating advantages over badly housed factories which show quickly in the cost analyses. The effectiveness of the factory building is itself largely determined by the plant location. Poorly located plants sometimes prohibit good layout, good natural lighting, or the development of a satisfied working force—all steps in which the structure of the plant plays a large part. The dollars and cents gain or loss that a given location brings to a particular company means much in competition within an industry.

Major factors of industrial location. The greatest influences on the location of factories are exercised by the major factors of industrial location, labor, market, power, and raw material. These influence different industries in varying ways, depending on the type of commodity manufactured and its requirements for labor or power in manufacture, its demands for raw material, and its ease of transportation to market. These major factors frequently determine that a plant must be located within one of several areas in which these conditions are most advantageous for it. The exact location, within the general area, may be governed by other considerations.

American pottery manufacture has developed, through many decades, in two main localities centering in Trenton, N. J., and East Liverpool, Ohio. Most pottery manufacture demands an exceptional grade of skill on the part of large numbers of the workers. This condition has caused new factories to seek these two centers for the location of their plants, although the materials used come from the four corners of the earth, and the product is marketed as widely. If a product be bulky, its value small, and there

are no other limiting factors, it is likely to be produced near its market. Thus cheap furniture is manufactured in considerable quantities in nearly every large city. Conversely, high-grade furniture is mainly manufactured in localized centers where there is a supply of skilled woodworkers. Plants such as cement works cannot be located where there is an absence of fuel because of the large amounts which are needed in the course of manufacture. Thus, though because of its bulk cement manufacture tends to be located near large cities, which are the greatest markets for its products, and though it needs bulky and cheap raw materials, nevertheless no cement plants are found in sections of the United States where fuel cannot be had at comparatively cheap rates. The influence of power is paramount in the location of abrasive and chemical plants, needing huge amounts in their processes, near the plentiful and cheap power of Niagara Falls. The search for cheap raw material has driven paper pulp plants far up into the spruce forests of Maine, Wisconsin, and Canada, despite the cost of transporting the bulky and relatively cheap product. Transportation costs on raw material are heavier yet, and locations usually provided originally for floating logs downstream to the pulp mill. But pulp mills need huge amounts of power also. So the location within the area of raw material has been at the point where water power has been available. Canning factories are influenced in their location almost wholly by raw material. Sugar refineries locate on water near the seacoast, so that they may receive their bulky raw material by the shipload. (See Fig. 13.)

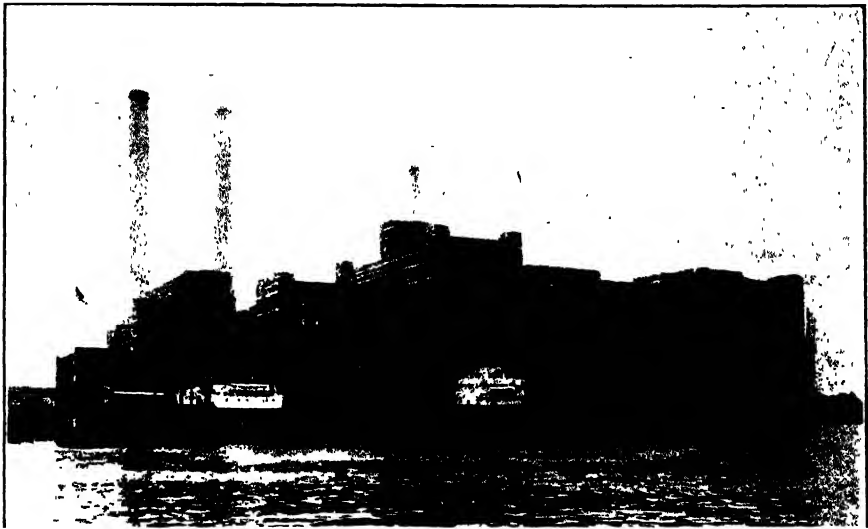
Not all industries have been influenced at the start by these major factors of location. For instance, the growth of the brass industry in the Naugatuck Valley of Connecticut or of the tire industry in Akron can originally be ascribed to none of these major factors. However, after these industries once secured a footing in these locations, the advantages of labor supply and the miscellaneous advantages inherent in specialized centers won for these two localities the recognition as centers of their particular industries.

Advantages and disadvantages of specialized communities. Given an area in which a factory may locate because of the influence of the major locating factors, the selection of a specialized center within that area is always of distinct advantage. Management problems are simplified in a variety of ways by plant location near other similar industries. Not only is there a trained labor supply available in such localities, but the ease of financing the business and selling the product is enormously increased. Examples of this are found in Minneapolis flour milling, and cotton spinning in the manufacturing districts of the South.

The banks in such communities are familiar with the needs of the business, have a knowledge of good business practice in the industry and usually are willing, to the limit of their ability, to aid in any legitimate way. Other

industries located in one-industry communities, conversely, frequently find it extremely difficult to secure the co-operation of the bankers in handling their accounts properly. Sometimes they are even forced to go out of town for accommodation in times of extreme need.

Buyers gravitate to localities in which an industry is centered. Sometimes, indeed, a dominating market can be established in the town in which the goods are manufactured. Thus, the periodic furniture expositions of Grand Rapids attract furniture buyers from all over the United States. A mark that indicates that furniture is made in this city aids the retailer in disposing of his stock, increasing both his and the manufacturer's turnover.



Courtesy, Stone & Webster, Inc.

FIG. 13.—The American Sugar Refining Company, Baltimore, Md.

Another benefit of location in specialized communities is the proximity of machinery manufacturers who make the type of equipment that is used in the industry. Required machinery can be procured at short notice, and, more important, repairs to machinery can be secured quickly. If the machinery manufacturer himself is not represented in the specialized center, it is probable that repair shops will soon spring up. This appeals particularly to companies which are not large enough to maintain their own repair departments. A similar advantage of the specialized center is the influence that the industry exerts on municipal ordinances. Thus the silk industry of Paterson, N. J., has been able to have ordinances passed to eliminate the smoke nuisance there.

Other factors have caused problems to arise in some industries which are causing manufacturers to move outside the specialized center. Specialization within an area may bring with it unionization of labor within the industry. Those manufacturers who do not desire to employ union labor have found this a cause for removal outside the area. Of course, this practically amounts to a challenge to the union to organize in the new location, and such removals have often been followed by employer-union warfare. Specialization within a community leads to much "shopping around" by purchasing agents in times of depression, and therefore the fact that they come to the market to buy is not an unmixed blessing to the manufacturer.

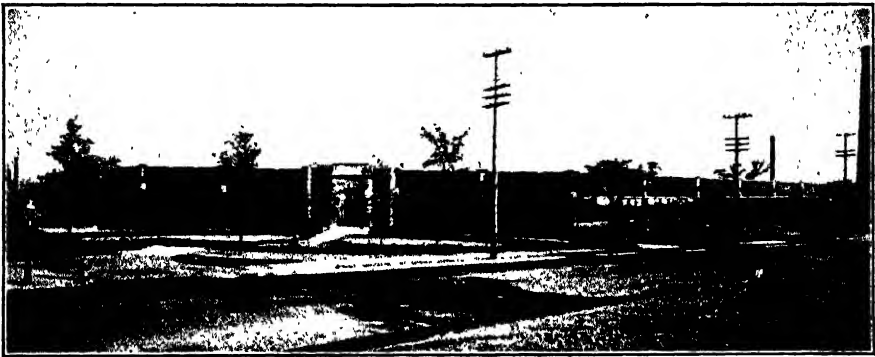
Location advantages of the large city, the small town, and the suburb. A plant may locate in a specialized section and still have a choice of a large city, a small town, or a suburb of a large city. Such a choice is to be found particularly in such sections as the shoe region of New England, or the automobile regions of Ohio and Michigan. The choice of location for a textile plant between the Northern textile manufacturing centers and the Southern ones is partially a choice between large-city location in the North and small-town location in the South.

If the specialized area be a great city, many of the advantages of the location within that city can be gained by location nearby, while at the same time some of its disadvantages may be avoided. Thus the automotive plants of Pontiac, Flint, and Jackson, Michigan, have most of the advantages of those located in Detroit, while at the same time they are not faced with the transportation problems or the taxes incident to location within Detroit.

The big-city location. The big-city location has its distinct advantages. All the advantages of the specialized region are sure to be found here, and found in greater abundance than elsewhere. Besides, there are unusual educational and amusement advantages. The educational advantages are not only those for the children of the employees which may make the latter desirous of being in the larger town, but more especially the trade and industrial educational advantages. Evening schools for the workers, which make them more valuable to their concern and to themselves; discussion groups for the executives, such as advertising clubs, production, and engineering organizations; foremen's training classes, and many other types of modern industrial educational opportunities are to be found in the big city. They represent a real reason for location in the city rather than in the small town. These advantages can also be enjoyed by the firm that is located in the suburbs, provided the transportation facilities are good.

Not the least of the big-city advantages is the fact that, even in specialized communities, there is always available a more diversified working-force than is the case in smaller communities. It is always possible to

secure male or female labor, as is desired. Of course, specialized communities that employ only male labor always tend to build up complementary industries, regardless of the size of the community. The advantages of big-city location are offset by disadvantages, in the eyes of many industrial executives. For instance, the small plant is likely to be at a disadvantage in a big city because it is forced to find a location in a loft building. Though this type of factory building is particularly common in New York, it will be found in almost every large manufacturing city. The loft building is the refuge of the man who seeks to take advantage of a labor supply near at hand, as in the clothing trade of downtown New York, or the textile industries of northeast Philadelphia. The loft building makes difficult the development of modern management, not only in the company that uses it, but in the whole industry nearby.



Courtesy, The Ballinger Company.

FIG. 14.—The Atwater-Kent Manufacturing Company, Philadelphia, Pa.

It is difficult to maintain working standards against the type of manufacturing competition that rents a floor, rents machines, forgets the existence of overhead, and proceeds to make hay during the sunny times of industry. It is this type of manufacturing enterprise that is likely to be the first to fail in times of business depression, but in failing it cuts and cuts prices until it makes competition exceedingly hard for larger plants with big plant expense and a vision of the future.

Some years ago there was a tendency to locate big-city plants in the center of a thickly settled manufacturing district, where ground was expensive, future expansion difficult, and attractive settings almost impossible. With the development of high-speed transportation within great cities this condition has changed, and within the boundaries of these cities new plants are locating under conditions which approximate suburban location. In fact, arbitrary boundary lines are frequently the only difference between city plants and suburban plants now. (See Fig. 14.) In medium-sized

cities, attractive settings have always been possible, as at the plants of the Eastman Kodak Company and The Art in Buttons Company in Rochester, N. Y.

The small-town location. Many of the advantages of the big city are lacking in the small town. A diversified labor supply, amusements for the high-salaried men, and other features are usually lacking in greater or less degree. It is an important fact that the high-grade executives tend to locate near the larger cities. Social advantages for their wives, amusement and musical advantages, and the absence of the golf club from many small country towns are all factors which make it difficult for the large plant to locate away from the big city. The \$10,000 man generally is not willing to spend most of his time in a place where he is not able to spend a substantial share of this sum on amusements or personal improvement of one kind or another.

The small town does offer certain very definite inducements that the large city cannot give. Low taxes, coupled with definite rebate of taxes in many cases, is one factor. Many small towns give free land, or even erect buildings and give bonuses to large industries to locate within their borders. Thus the city of Cumberland, Maryland, secured the huge new plant of the Kelly-Springfield Tire Company largely because of such concessions. This factory was literally brought to Cumberland by popular subscription. There is a real danger in placing too much emphasis on such factors if more basic conditions are not advantageous.

Although small towns do not have a diversified labor supply, and although trained labor for a new industry usually is absent, this is partially counterbalanced by the fact that the town's industries are not likely to absorb the total available labor supply of the community. This has become particularly true since women have entered so extensively into industry. While labor supplies are untrained, they are more easily trained in the technique of a given industry than is labor in a large city, because the absence of alternative opportunity makes the workers desirous of learning. The outstanding illustration of this is to be found in the movement of textile industries into Southern towns which previously had supported but little manufacturing.

The suburban location. The type of location which provides most of the advantages of both the big city and the small outlying town is the suburban location near the big city. This accounts for the very rapid development of the "metropolitan districts" near large industrial centers during recent years. The one-story structure is here possible. The inducements are sometimes offered by the suburban community too; at least the ground is cheap and the taxes are low. The advantages of the big city nearby are usually to be had by all the staff sufficiently frequently to keep them contented, particularly if the housing conditions in the suburb are as

good or better than in the city. Executives can utilize their automobiles either to go to the plant from their city homes or from their suburban homes to the city amusements. Railroad facilities are usually as good as they are in the city. In fact, they are likely to be better, in that spur tracks are easier to secure and they can be arranged to suit the needs of the plant. All the advantages of having several competing railroad lines, which usually are found in a big city, are to be had, and the dependence on one railroad company, which is often the bane of the small town manufacturer's existence, is not faced.

There is practically no disadvantage that can be named for the suburban location. In fact the advantages of good working conditions, which are usually found in the light, airy building that can be erected in the suburbs will be found to be a magnet that will draw the labor supply from even distant sections of the neighboring city. Industrial plants which have moved to suburban locations within recent years have found that they are able to take with them a large share of that portion of the force which they wanted.

Industrial housing. The industrial town is best known to the public through its development in the remote mining camp of the West or in the coal-mining regions of the East. Most of the publicity that it has received has not been favorable, and there is a prejudice against industrial towns which must be overcome by the individual company. Early attempts in the construction of industrial towns were largely failures because they were built on a paternalistic concept which was unsound.

Present industrial housing plans are being developed in the light of much experience, both successful and unsuccessful. Pullman, constructed about 1880, was the first of the large industrial cities. Gary, completed about thirty years later, has secured the most publicity. Neither of these towns aroused generally favorable comment. Pullman was paternalistic. At Gary, the company did nothing toward housing the unskilled employees. Recent industrial towns have been more successful, as in the case of the big project of the United States Steel Corporation at Fairfield, Alabama.

The company has a proper interest in the living conditions of its employees, provided that it does not carry that interest to paternalistic extremes. The worker who is in a plant for an eight-hour day is there only about one-quarter of the year. Everyone is agreed that conditions in the plant affect the workers' health. If this is true, how much more must their health be affected by conditions in the home. Health and production are directly related. Furthermore, the costs of changing employees continuously will be decreased if the employee can live in a better home when working for a particular company. The cost of replacing employees may be found to be larger than the interest rates on the money that a company may tie up in an industrial housing project.

Furthermore, in new manufacturing communities, such as the Southern Piedmont, it is necessary for the company to erect whole villages. Mr. Henry P. Kendall, of Kendall Mills, Inc., with extensive interests in the South, has said, "Streets are resurfaced, sidewalks built, landscape gardening begun, and workers' dwellings remodeled and equipped with baths and other conveniences. Churches are repaired and painted, or perhaps built, and facilities of entertainment are introduced."¹ Fine schools have been built as a part of such factory villages. (See Fig. 15.)



Courtesy J. E. Serrine, Co., Greenville, S. C.

FIG. 15.—School at Pelzer Mfg. Co., Pelzer, S. C.

Industrial houses may be company-owned, and may pass into the hands of the worker through the financial assistance of the company, or may be owned by a separate corporation, in turn owned by employer and employees. For the company to own permanently a large share of the houses in a town or village is likely to result in the abuses that have brought condemnation upon industrial housing projects in the past. One of the latter two types of ownership is more successful, particularly in older manufacturing communities. If town management is to be undertaken by a company, it must be considered thoroughly ahead of time, for it is a heavy financial burden. However, most programs do not involve town management, but an addition to housing facilities in a town already organized.

¹ Bulletin of the Taylor Society, December, 1927, page 524.

CHAPTER X

PLANT LAYOUT

It is costly to have products which are being manufactured retrace their steps through the factory building. It is also costly to have heavy products worked upon in upper stories to which they must be transported for manufacture and from which they must be brought down after manufacture. Millions of pounds of factory goods have been unnecessarily rehandled and unnecessarily lifted in factories year after year, because of improper development of the layout of the plant. It is not enough in developing a factory to build a well-constructed concrete building and to have it adequately lighted and ventilated. It is necessary that the plant be constructed with direct thought of the way in which it is to be utilized, and with thought of elimination of excess back-tracking of product.

The modern factory building is developed so that all processes are thoroughly considered and related one to another and to the plot of ground which is available, and then the building is designed properly to house these processes. Thus proper layout is assured, as contrasted with the older idea of endeavoring to fit manufacturing processes into a building already constructed. A building which is suitable for the process, but which can be converted for other manufacture, is better than one which is not so adapted. Changes in process and product occur continuously. Therefore, though a building should fit the use to which it is put, it should not be too highly specialized.

The importance of the factory building as a primary tool with which to carry on production, and into which all other production tools and mechanisms fit, cannot be overestimated. Like all other tools, the factory building must fit the job to be done if that job is to be done most effectively. Defects in factory building construction are often so primary and organic as to make impossible remedying them after production is begun. Hence they are often of more continuing importance than disorders in other phases of management, which can be made to respond to the treatment of the executives. An ineffective plant creates a burden in all of the daily operations of the business. Thus the modern factory building is far different from its predecessor of not so many years ago, different mainly because it is built to house a given set of operations and given organization conditions, whereas formerly the factory building was

put up, and the organization conditions and operations were made to fit as best they could.

Factors that influence plant layout. In developing a building, it is essential that the type of industry, type of product, type of operations, and type of worker be considered. For consideration of layout and many other management steps, industries may be thought of as continuous or assembly.

A continuous industry is one in which all the material is received at one point, from which successive operations turn it into finished product, as yarn-spinning, paper, and pottery manufacture. An assembly industry is one in which the finished product can be produced only after various components have been made and then brought together for final operations, such as the manufacture of shoes, clothing, and automobiles. From the standpoint of factory layout, this difference is significant. Some continuous industries are synthetic, that is, the product is obtained by bringing together various ingredients which are worked up in manufacture, as paper manufacture or yarn-spinning. Other continuous industries are analytical, that is, the product is obtained by continual processes that separate the final product from the mass of original material. All refining industries, such as oil and by-product coke, are of this nature.

Assembly industries are also of two types: first, those in which the components are similar and go through similar operations, as, for instance, clothing; and second, those in which the components are dissimilar and go through unlike processes, for instance, shoes and automobiles.

The type of product, that is, whether the product be heavy or light, large or small, liquid or solid, is another fundamental consideration. Although the manufacture of spark plugs and locomotives both involve assembly work, layout problems differ materially. Layout problems in any plant in which the product can be flowed, either by gravity or by pumps, from one operation to another, as in flour or sugar manufacture, differ materially from those in which work in process must be handled by hand, conveyor, or truck in moving from one operation to the next.

Certain types of operations make it imperative that they be considered first in making layout plans. Such are wet operations, as leather-tanning or textile-dyeing; operations involving heavy machinery, as large hydraulic presses; and operations which involve fire risk, as in the manufacture of powder or linoleum.

The type of worker is important as a fundamental consideration, particularly in the employment of women workers, where many decisions concerning factory layout must be changed because of the requirements of these employees.

Size and type of factory building. The selection of a given size or

type of factory building is dependent on all these considerations, is dependent upon the application of the ideals of layout shortly to be considered, and is also dependent upon the location which has been selected for the factory. Frequently the selection of the plant location will be partly dependent upon factory layout. For instance, if it be determined that a series of small, scattered units is preferable to one large plant, this would most certainly mean that a suburban location would be improper, and that the small plants must be located in various parts of one or more cities or towns. The type of building to be erected and the ground space to be occupied are very likely to affect location. As in most management decisions involving policy determination, it will be found that there must be an interplay, an inter-relationship of the factors concerned, and that location, layout, size and type of factory buildings are linked up, each with the other.

Not only are these phases of the factory housing problem linked up with each other, but they are very closely associated with the problems of organization. A change in the method of housing an enterprise should generally result in necessary changes in the construction of the organization, in order that supervision may be made most effective. Conversely, a change in organization may make it absolutely essential that certain physical aspects of the factory building be modified. For instance, if it is decided to place several departments under the control of one superintendent, it is necessary that these departments be so located that the superintendent may be accessible easily to the foremen of the departments, and that he in turn be able to visit the foremen without the loss of too much valuable time. In one plant, which does not operate elaborate staff departments, and thereby increases the importance of its superintendents accordingly, one of the superintendents has been given control of three departments, doing similar work, but located in three mills, each about half a mile from the other. It is not difficult to trace the causes of many delays in production; the superintendent cannot be found when he is wanted.

How large should a factory be? It has been concluded frequently that the larger a factory grows, the more economies of operation through mere size, can be effected. This idea is probably linked up with the general American concept of hugeness as a goal at which to aim. Merely because there are distinct advantages inherent in large-scale operations, it does not always follow that such operations must be carried on within the walls of one plant. There are many advantages to be secured by the huge multi-acred plant which has come to be looked upon as typical of the new industrial day. On the other hand, we see everywhere about us, in industries which permit, small plants which are not only able to compete with their huge rivals, but which frequently produce far larger

returns per dollar of invested capital. How is that possible in these days of large-scale production, integration, and control of markets of raw material and finished product? The answer lies almost entirely in the management problems involved in operating the large plant and those involved in operating the small plant. The small plant has certain very definite management advantages which are causing managers of large plants to question the limits of economies from large plants and ask, "How large should a factory be?"

Size and type of building will be seen to be directly related to the establishment of functional departments. If these departments are established they must of necessity be so located as to make possible immediate contact with all portions of the line organization of the business. This is particularly true of a central planning department. If staff departments be organized, they may cause the erection of one large plant, so constructed and laid out as to give them complete opportunity for contact. If a number of small buildings should be established, it would mean that effective action from the staff departments would be made more difficult. To have such a department represented in each of the buildings probably would mean an increase in overhead expenditures, which would be likely to defeat the whole purpose of the department.

There is a difference in the personnel problem in the large plant and in the small one. No matter how effective the organization steps, committees, or leadership, in large plants, it is impossible for the worker to be in actual contact with the men really running the plant. For administrative purposes, workers must be numbered, and must be known on the payroll more by their numbers than by their names. This is but an evidence of the impersonal contact which is a direct resultant of the growth of huge organizations. Many management devices have been instituted for the single purpose of minimizing this impersonal relationship in so far as it is possible. Small plants can eliminate these devices. The close relationship between the head of the organization and the worker, that has passed so largely out of industry with the coming of the big corporation, has led to the survival of the small company in many individual cases.

Under present economic and industrial conditions times of depression are inevitable and constantly recurrent. This should influence directly the size of the plant. Businesses which have several plants are enabled to shut down one of these entirely at such times. Businesses that have but one big plant must shut down a portion of that plant. This latter course means that the workers throughout the organization are affected because of the shutdown of one small section of the business. They see other men and women thrown out of work, and they naturally ask, "Aren't we next?" or "Shouldn't we decrease our production so that

there will be enough for all of us? " It is true that knowledge may come to plants that are still running concerning other plants of the same company which have been partially or completely shut down, and that this may affect production slightly in an unavoidable way; nevertheless the effect is far different from the shutdown of a portion of the same factory. In the latter case the workers who remain know large numbers of the workers who have been laid off; the whole action is so close that they necessarily feel that they are "next." The net effect is that the business is more affected by the depression on account of the higher production costs.

One large manufacturing concern has recently decided on a policy of a number of small plants instead of one huge one, largely on the basis of the resale value of their buildings. They have felt that conditions in their particular industry are likely to change so much within the next ten or fifteen years that any building which they might put up for themselves to-day would be entirely out of date at the time. They have felt that the resale value of a number of small plants would be far larger than that of one large plant, specially constructed for their particular needs. Acting on this one basis, they have vetoed the one-large-plant idea. This may be a special case, but it indicates how broad are the considerations which management must keep in mind when deciding on the selection or erection of a plant.

Industries manufacturing large or heavy products with nation-wide distribution are always face to face with the freight-rate disadvantages inherent in one large plant, no matter how central its location may be. One of the best examples of a method of coping with this problem, and one that has been largely followed, is that of the Ford organization. The idea of assembly plants in many parts of the United States, with the product shipped to them from the main factory in knocked-down condition, and the consequent saving of the freight involved, proved so successful that it was not long before the example was followed by other automobile concerns and by other lines of industry. An example of this idea in other lines of industry is to be found in the utilization of "fabricating shops" by steel manufacturers. More or less rough shapes are shipped to locations near the big cities or other centers of consumption, and are there worked over, or "fabricated" in accordance with the needs of the local community. In this way, not only are freight rates saved because more pounds of steel can be put in one freight car, but the operations of the mill become more standardized and management problems correspondingly decreased. The diverse operations of fabricating are left to the fabricating, or what practically amount to assembling, plants in their scattered locations.

The Western Electric Company presents an excellent example of a

company which has been brought close to the problems of nation-wide distribution. For years this company had but one large manufacturing plant, at Hawthorne, near Chicago. The increase in the size of the business finally brought a change in policy, with the erection of another large manufacturing unit at Kearny, New Jersey, near New York City. Although at present each plant manufactures some articles not made by the other, nevertheless, both plants make many of the same items. The distributing branches of this company have also been increased greatly in recent years, until they now represent more than forty storehouse and maintenance units scattered throughout the United States.

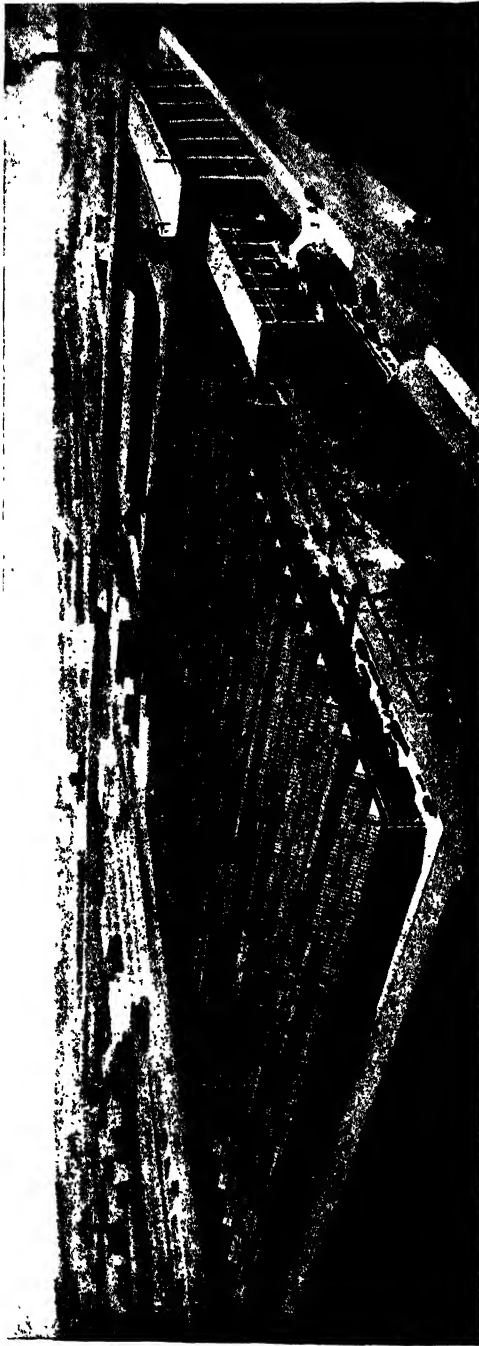
The small-department idea. Many companies have adopted the small-department idea as the basis of their layout. This means that a limit is set, beyond which a given department is not allowed to grow. When the work of a department grows beyond the limit set, there is created another department under the same roof, doing the same work, but under different supervision. The layout in many new buildings provides for such division in the first instance. (See Fig. 21.)

Some managers feel that such a plan makes for more adequate supervision. They feel that one foreman or superintendent cannot carry the details of operation of more than a certain number of machines, a certain number of operators, or a certain number of units of product in mind. They say that no matter how much you may allow him to delegate his responsibility, the fact remains that he is responsible for more work (not necessarily more functions) than he can handle. Therefore they have split their similar operations into several departments, under the control of different foremen, whose relationship to the remainder of the factory organization is exactly the same as if the work being carried on under their respective supervision were of an entirely different nature. The element of competition between like departments is a valued feature of this plan. Some companies separate all overhead by competing sections, and others even install separate electric meters to measure the power used by the several departments.

Type of building. Whether the building should be one-story or multi-storied is another basic layout problem. The lowest cost per square foot of floor space can be secured usually through the use of three- to five-story structures if the ground be valuable. Otherwise the lowest cost will be found in one-story, or one-story and mezzanine structures. With the addition of stories above five or six in a factory employing many workers, the cost per square foot of usable space is likely to increase rapidly, because the effective area is reduced by the service features, such as stairways, fire-towers, and elevators. The cost of foundations and the space occupied by supporting columns also increases with the number of stories. The repair charges incident to machines operating on various

floors at varying speeds and rhythms must also be taken into account. Among the factors that must be considered in making the final decision are the cost of ground, building construction costs, and operating costs, such as costs of conveyors *vs.* elevators.

Many managers have inclined toward the suburban location because there they can establish a one-story shop. They feel that they can secure better light and ventilation in the one-story structure. One element of cost that is reduced, particularly in plants that use heavy machinery, is the cost of foundations for the machinery. Furthermore, the vibrations from operating machinery, which are a large element of cost in maintaining proper alignment of shafting are practically eliminated, the machinery being set directly on the ground. Materials are more easily handled in the one-story building, as their elevation, particularly in



Courtesy Proctor & Schwartz.

FIG. 16.—A One-story, Saw-tooth Building, Proctor & Schwartz, Olney, Philadelphia, Pa.

the case of heavy goods, is expensive. The elimination of supports for upper stories not only gives more floor space, but makes it possible to lay out the shop entirely from the point of view of the needs of the plant, without regard to restrictions imposed by strains and stresses from upper floors.

Some departments grow more rapidly than others, and this growth cannot be foretold exactly. With light goods, or goods that can be moved by gravity, pumped, or blown, the advantages of the one-story building are eliminated. (See Fig. 17.)



Courtesy Stone & Webster, Inc.

FIG. 17.—Bag-filling Machines, showing use of Gravity in Layout of a Sugar Refinery. The American Sugar Refining Company, Baltimore, Md.

Ideals of layout. In developing the layout of a particular plant there are certain ideals which form the basis, but which must always be modified to fit the given conditions. These ideals are: proper balance of departments and operations; development of production centers; direct-line layout; short moves; adequate means of internal transportation; development of service centers; and provision for future expansion.

Proper balance of departments and operations. This provides for the elimination of limiting or bottle-neck operations, as well as over-equipment of any operation. This is of particular importance in continuous-pro-

duction plants. It is essential that the capacity of each department or of each machine working on each operation be sufficient properly to take up the production of prior operations and to transmit to following operations sufficient product to keep the equipment there fully utilized. Any other plan involves increased inventories of material in process, overtime work, with its attendant increased costs, and general confusion, including utilization of expensive factory floor space for material tied up while in process. In one textile plant it was found, after investigation, that the beaming operation was only able to supply a warp to approximately 450 looms, while there were 500 looms in the plant. It can be seen readily that this involved excess equipment charges on 50 looms, or operating the beaming department overtime, which, in this case, was difficult because of union regulations.

Development of production centers. Production centers, rather than workplaces, should be provided within the departments. Instead of considering the worker and his machine the unit for which space must be provided, each worker tending a group of machines or each machine tended by a group of workers should be looked upon as a production center. The production center should include the workmen, the machines, space for storage of raw material and completed units from the operation, supplementary apparatus of any kind needed in the performance of the operation, and a share of the aisle space required between that production center and the next.

The importance of the machine as the basis of production in modern industry frequently makes a factory floor a succession of similar production centers.

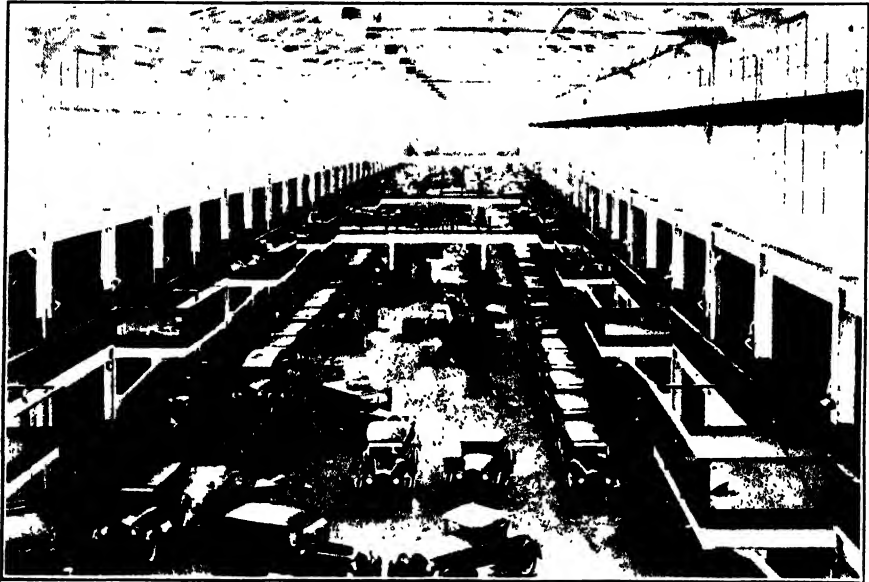
Layout in plants on quantity production. In plants on a quantity-production basis, machines and equipment are arranged so that operations will be continuous on particular components. Machinery is arranged so that successive operations are performed on successive machines. Moreover, the last operation will be performed at just about the point where the component goes into assembly, in assembly industries. If there is a conveyor to take the component to assembly, the operations will be laid out so that the last one ends at the conveyor.

In such plants, therefore, layout changes with changes in product or in methods of performing operations. When an engineering change is made in the product, one of the essential approvals that must be secured is that of the plant-layout department, or similar division. It is the function of this division to decide in what respects the change will affect present layout, how much it will cost to change the layout, or whether it is practicable to change it.

In quantity manufacture, such as is described in Chapter XLVI, the use of mezzanines is an advantage in assembly operations carried on in

one-story buildings. Conveyors from other buildings can end in the mezzanine, and the parts can be sent by gravity to the assembly floor. (See Figs. 18 and 19.)

Direct-line layout. This implies the processing of the product in one direction, or in one logical series of directions from start to finish, with a minimum of retraced steps or backward movements. This ideal can be attained most nearly in quantity-production plants producing standard



Courtesy Oakland Motor Company.

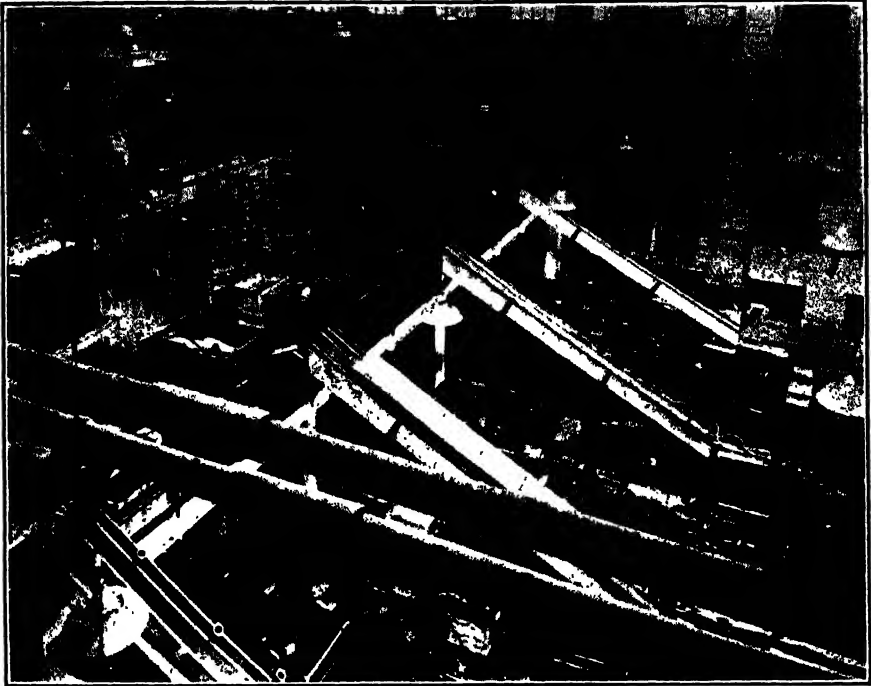
FIG. 18.—Mezzanines and Final Assembly Floor, Pontiac Cars, Oakland Motor Company, Pontiac Mich.

products, but even then it is complicated by the following factors which are always present in plants producing diversified products:

1. The use of the same machine on more than one operation in the process. It may be inadvisable to erect two machines, particularly if one operation will not keep one machine continuously employed.
2. The performance of two or more operations by the same worker, as in felling operations in the clothing industry. Where each part moves quickly and is easy to handle, it may prove cheaper to move the material than to move the worker.
3. The necessity of placing all operations in the production line with reference to the peculiar considerations already enumerated, such as the type of product or operation. Thus, many

operations must have special light, such as cloth-examining in clothing plants, or wool-sorting in woolen yarn plants, where the light must come from the north. Tanning vats in tanneries must be placed on solid ground because of their weight and the wetness of the operation.

Thus, in striving for direct-line layout, continuous compromise of the ideal is often necessary when facing particular conditions. Direct-line



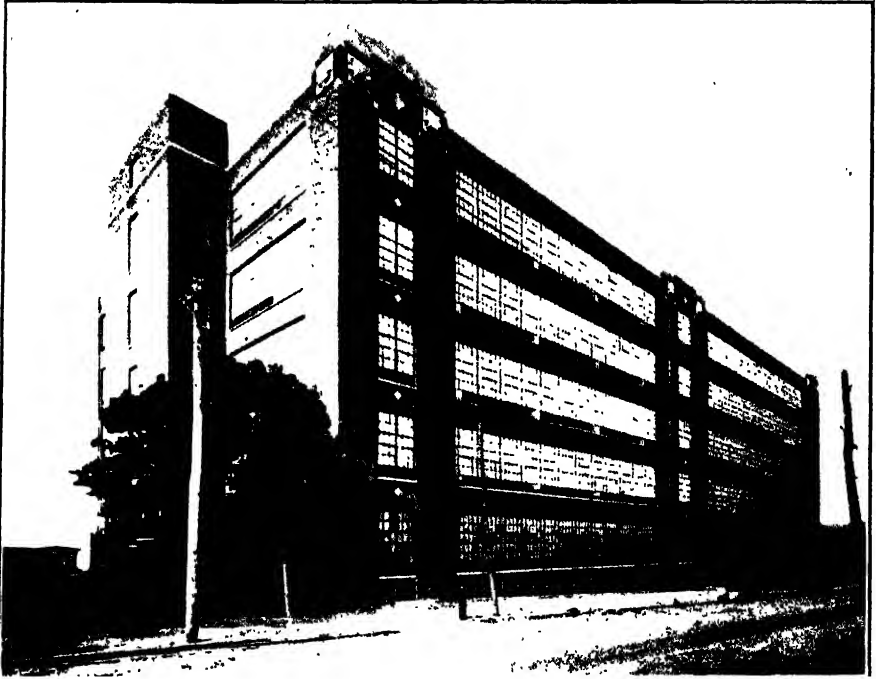
Courtesy Buick Motor Company.

FIG. 19.—Mezzanines as a Factor in Layout. Mufflers and exhaust pipes are gathered on this mezzanine at the Buick Motor Company, Flint, Mich., and are lowered down chutes to the three lines of cars passing below.

layout is applicable either to a particular floor of the factory or to the building as a whole. (See Figs. 20 and 21.)

The advantages that accrue from moving the product in a straight line are numerous; among them the following may be mentioned. The speed of production is increased, the cost of conveying and trucking within the factory is reduced, there is secured a minimum of noise and confusion within the plant, and there is a minimum of distraction because workmen are not journeying to and fro.

Short moves. The layout should be planned so that the transportation of the material from one work center to another involves as short a move as possible. However, it has been proved the poorest kind of policy to save space in a factory at the expense of men or materials. The mistake of crowding operators has been made, only to find that the subsequent loss of production per worker was far more costly than a comfortable layout would have been. Short moves are an extremely important



Courtesy James Lees & Sons Company.

FIG. 20.—Worsted Yarn Plant, James Lees & Sons Company, Bridgeport, Pa.

factor if the product be heavy and unwieldy. However, conveying apparatus, as described in Chapter XI, has greatly decreased the cost of long moves, and has practically put machines or departments at a distance from each other in direct line.

Adequate internal transportation. The first and most important factor connected with adequate internal transportation is adequate aisle space. This must be amply sufficient for all trucking requirements, and must be kept clear, possibly by painting white lines upon the floor. Main aisles must be considered separately from the space allowed when figuring production centers. This is fully described in Chapter XI.

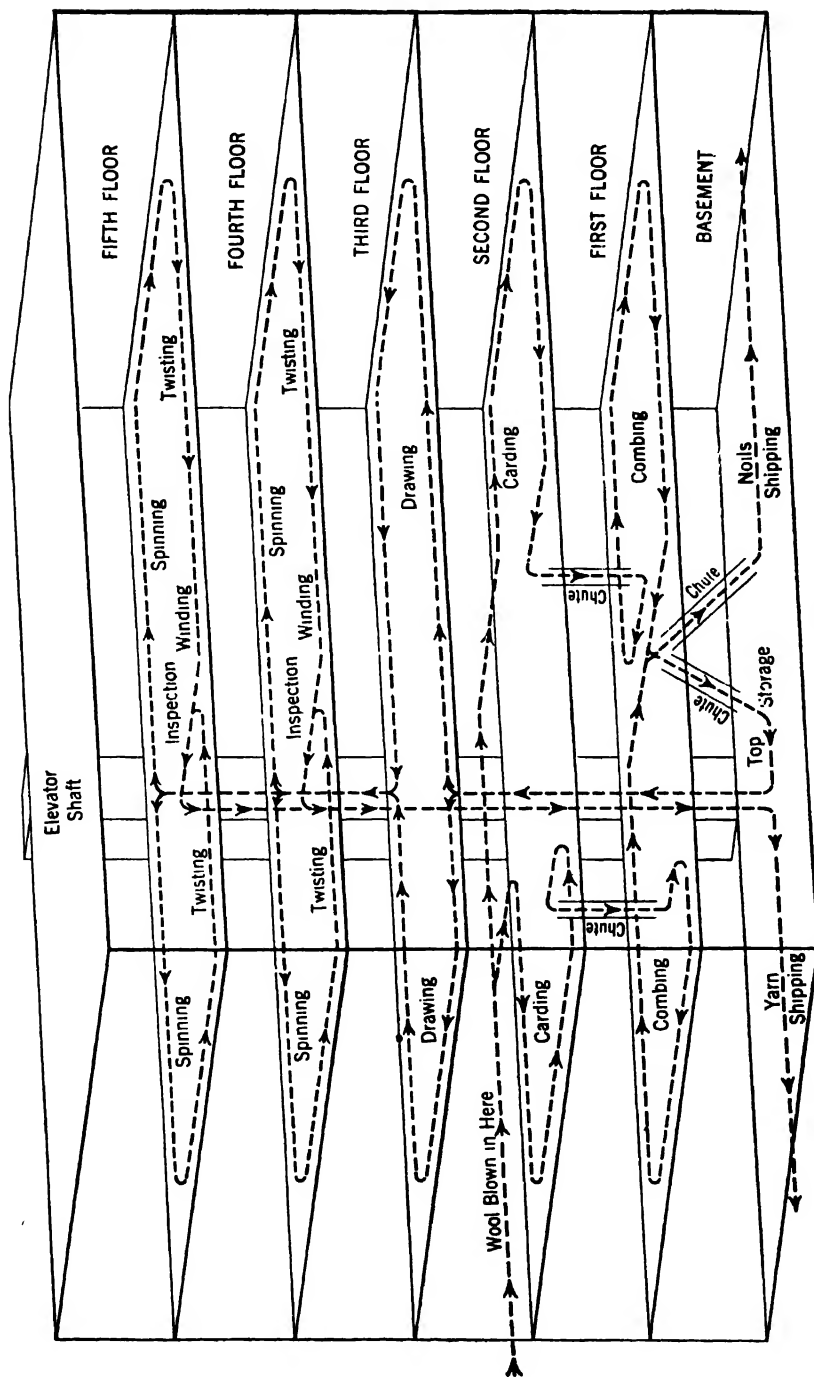


Fig. 21.—Vertical Layout, Worsted Yarn Plant, James Lees & Sons Co.

Development of service centers. By service centers are meant the tool, stores, dressing, rest rooms, and lavatories that form a necessary part of every plant. These centers should be convenient to the actual processes but should not obtrude upon them to the hindrance of production. The shorter the distance from the operations to these centers, the less time will be consumed by workers going to and from the workplaces. It is advisable to place the rest rooms separate from the locker and dressing rooms where possible, particularly where women workers are involved. As a rule, the service centers should be in those parts of the premises where the light is least desirable. Frequently, it has been found possible to place the service centers on balconies between floors. This is naturally a big space-saver as well as a convenient arrangement as regards proximity to the processes. Another good arrangement for these centers is to place them in divisions of the process or in natural divisions between buildings or parts of the same building. This tends to bring these centers into close proximity to the entrances, exits, and elevators. (See Fig. 22.)

An example of effective layout. The worsted-yarn plant of James Lees & Sons Company, Bridgeport, Pa. (Fig. 20), is an excellent example of the application of the ideals of layout, made with the necessary consideration of a number of limiting factors. Figure 21 illustrates the vertical floor plan of this plant. It will be noted that the raw material, wool, is blown on to the second floor. This comes from another building, where it has been washed. After the carding operation on the second floor, the material is dropped by gravity to the first floor, where it is combed. After being combed, the noils drop into bags in the basement, from which they are shipped by truck to the purchaser of these short fibers. The combed wool, in the form of tops, is also dropped down by gravity to the basement, into the top storage, where it is aged two weeks before further operations are performed on it. Although gravity is used in these operations, the material henceforth must be transported by elevator, because it is no longer in such shape that gravity may be used. The spinning, twisting, and reeling operations, which demand the most light, have been placed on two like floors, the fourth and fifth, while drawing is performed on the third, as the material comes up in the elevator from the top storage, which, requiring little light, is properly in the basement.

The fourth and fifth floors (see Fig. 22) are excellent illustrations of the small-department idea. There are two spinning and twisting units on each end of each of these floors, each under the supervision of a different foreman. One row of twisters takes the product from two rows of spinning frames, on each side of it (see Figs. 22 and 23), while after the yarn is reeled on to skeins it is inspected and sent down the elevators to the basement for shipping.

The service centers, dressing rooms, lavatories, elevators, and stairs

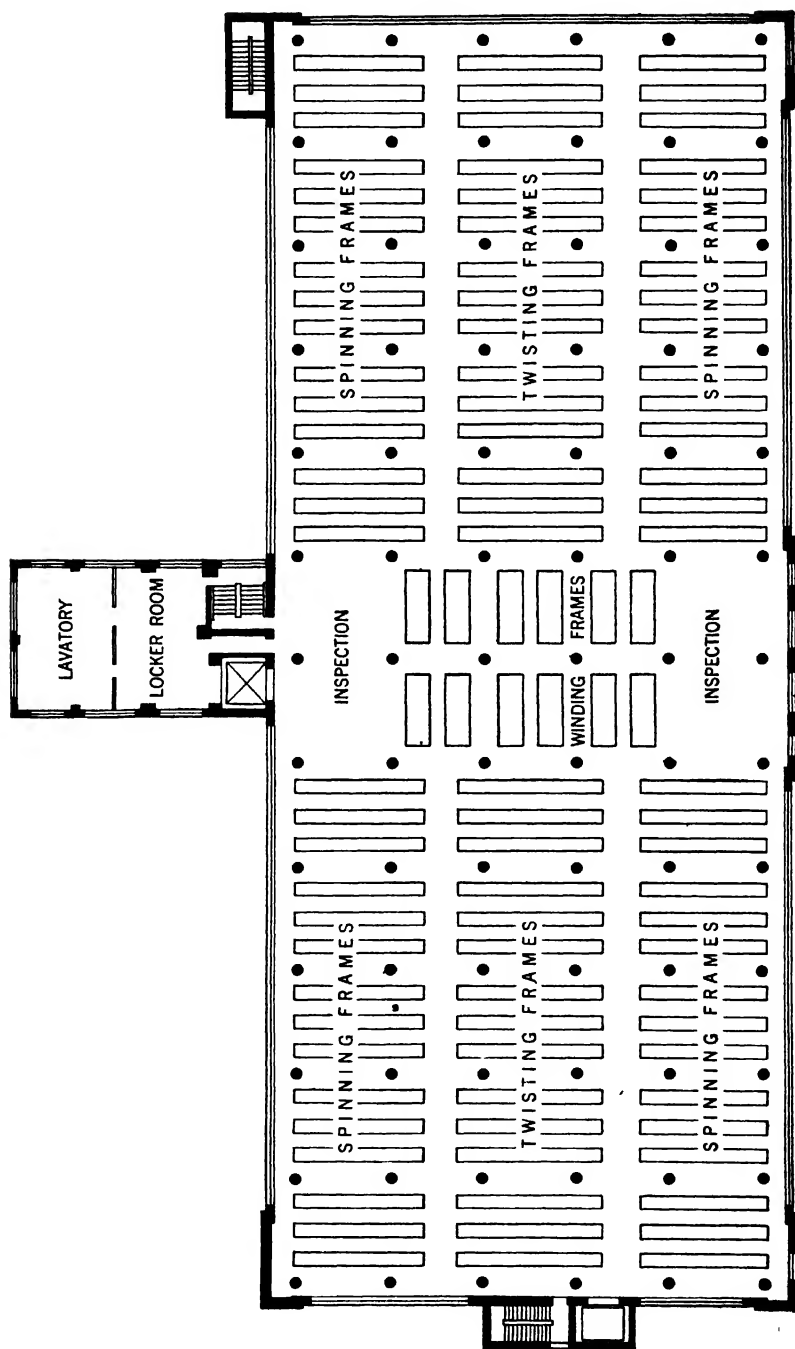
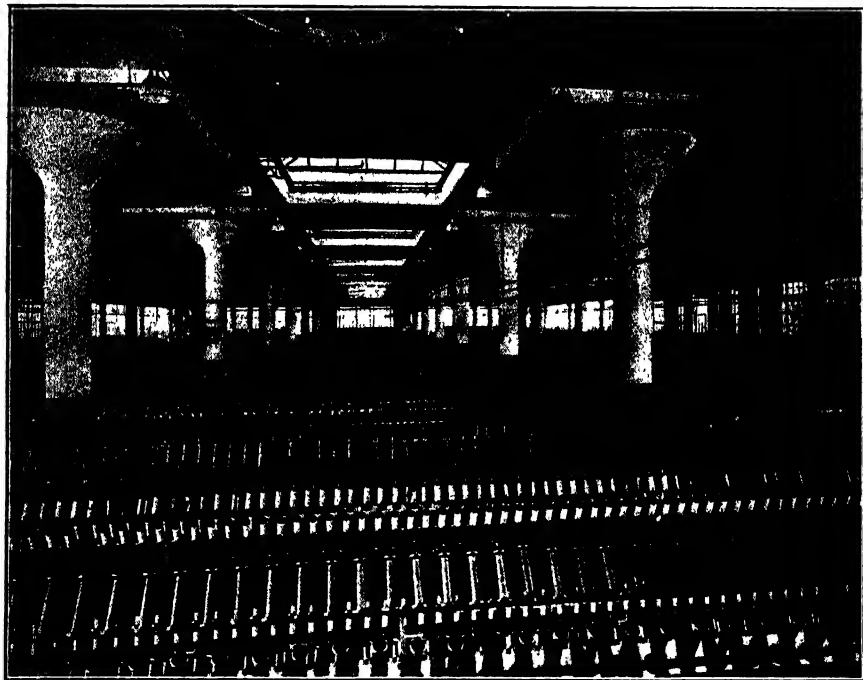


Fig. 22.—Layout of Spinning Floors, Worsted Yarn Plant, James Lees & Sons Co.

are located in a wing at the back of the center of the building, while there are fire-towers for safety at each end.

On the third floor, the drawing frames are arranged so that the tops are placed on the frames in the center of the floor, and the finer drawing operations, requiring more light, therefore are performed near the windows on each side of the building.

An interesting feature of the James Lees & Sons Company building is the absence of all exterior columns, permitting continuous natural light



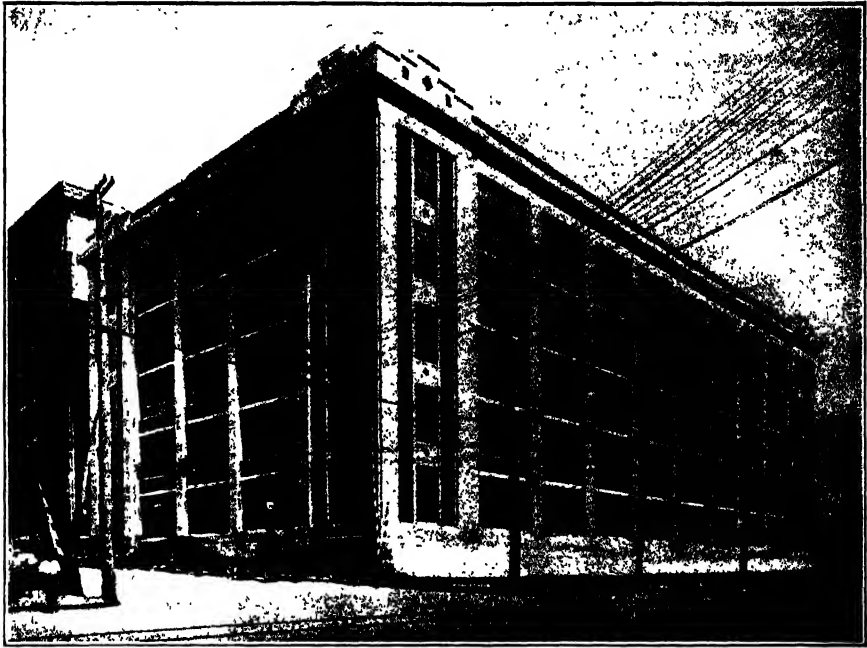
Courtesy The Ballinger Company.

FIG. 23.—Fifth Floor Spinning Units, Worsted Yarn Plant, James Lees & Sons Co.

to flood the whole interior, except where broken by stairways or other necessary features. Comparison of this building with another modern building, that of the Durham Hosiery Mills, Durham, N. C. (Fig. 24), will indicate this.

Provision for future expansion. In new buildings, provision is usually made for future expansion. In the building just described, expansion would be in the form of another unit, connected with the present building at the wing in the center. Logical enlargements may be made to buildings constructed along the so-called U, L, H, T, or E types illustrated in Fig. 25.

Making the layout. In making the actual layout for a plant it is most important to have complete information at hand before the layout is



Courtesy J. E. Sirrine Co., Greenville, S. C.

FIG. 24.—Marvin-Carr Building of the Durham Hosiery Mills, Durham, N. C.

made. By this is meant all such information as size of production centers, size of storerooms needed for raw materials, partly finished and finished products, space needed for tool rooms, auxiliary equipment, office and

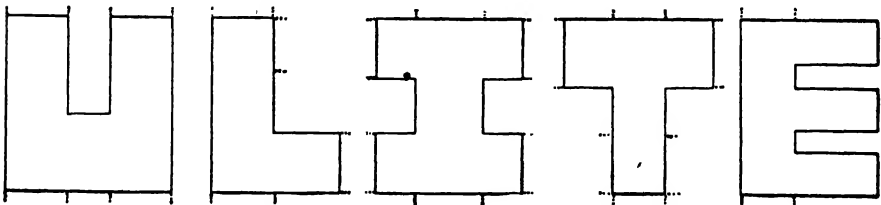


FIG. 25.—Ground Plans of Industrial Buildings Indicating Possible Directions of Expansion.

production department requirements, aisle space, recreation rooms, service centers, boiler- and engine-room requirements, and all other similar departments or facilities requiring space. Every required square yard of

space must be estimated before final plans are prepared. Future expansion must always be borne in mind and provision made for it. A frequent mistake is that of not providing for expansion or not providing enough space really to fill future needs.

With such detailed knowledge at hand, together with a recollection of the ideals for plant layout, and with the building construction expert always available for consultation, one may proceed with the actual layout. An excellent method is to make, of cardboard or paper, small, scaled templets representing each machine or group of machines in the process. These should be laid on an outline plan of the building drawn to the same scale. By this means the almost invariable changes and shifts in plan may be made without expensive and time-wasting drafting work. These shifts are necessary in almost every case. It is best to proceed very cautiously, looking at all times for the unexpected difficulties. The tendency to forget the aiseways and floor storage spaces is great. The location of the templets on the floor plans is frequently based on an aisleway which has been determined upon and definitely laid out with proper relation to the stairways, elevators, or runways. When the templets are completed and approved, the whole may be transcribed to blue-prints.

CHAPTER XI

MATERIAL HANDLING

THE importance of material handling in plant layout, and as a factor in modern industrial processes, has already been suggested. It constitutes one of the largest items of cost in modern manufacturing. Material handling can be reduced somewhat by proper layout, as through the use of assembly lines (see Chapter XLVI), but it cannot be eliminated wholly. In recent years modern material-handling methods have reduced these costs greatly, but further economies through the use of recently devised mechanisms will doubtless make these savings only a beginning in the near future.

Some material-handling devices make for improved layout by connecting widely separated parts of the factory (see Fig. 26); some better the technique of the process itself (see Fig. 27); some make possible an increase in the weight and size of the unit of production (see Fig. 28); while some assist in shipping the final product (See Fig. 29).

The first developments in mechanical handling included overhead cranes, jib cranes, and locomotive cranes. Overhead cranes still play an important part in material handling within our manufacturing establishments. Figure 30 shows a craneway in the Twin Cities manufacturing plant of the Ford Motor Company. It will be seen that in this craneway freight cars are brought directly within the building, and their unloaded cargo can be transported to any part of the bay by the cranes. The floor is at the level of the car doors. In heavy manufacture, the selection of a site that allows railroad tracks to be placed through buildings, and railroad freight cars to be spotted at any desired point, from which the material may be handled by cranes, is an important feature of plant location. Layout of buildings with due consideration of the permissible curves of railroad tracks is an important element in material handling within such plants. (See Fig. 31.)

Mechanical unloading devices, such as that illustrated in Fig. 32, form an important means of saving labor in material handling. In the conveying of bulk goods, such as lumber, and package goods, such as those in Fig. 29, standard equipment may be used, the only needed adaptation being that of securing proper lengths.

Tiering machines (see Fig. 33) and other equipment for handling



Courtesy Chain Belt Company.

FIG. 26.—Bringing Tires from the Manufacturing Floors to the Storeroom at the Firestone Tire and Rubber Company, Akron, Ohio.



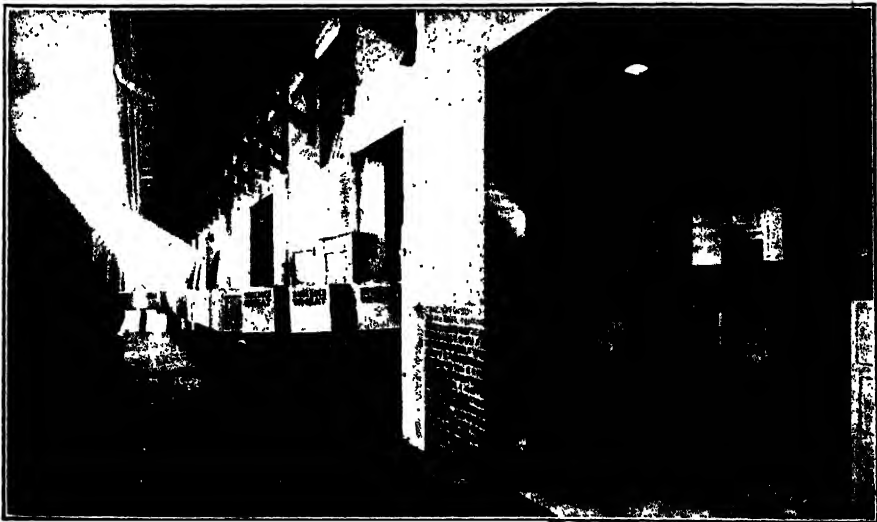
Courtesy Chain Belt Company.

FIG. 27.—Conveyor Carrying Automobile Chassis from Paint Room to Assembly through Asbestos-enclosed Steam Drying Compartment, Nash Motor Company, Racine, Wisconsin.



Courtesy The Cleveland Crane and Engineering Company.

FIG. 28.—Two Tramrail Carriers Doing the Work Which formerly Required Thirty Men in a Waste-paper Warehouse. Each of the bales weighs seven hundred pounds.



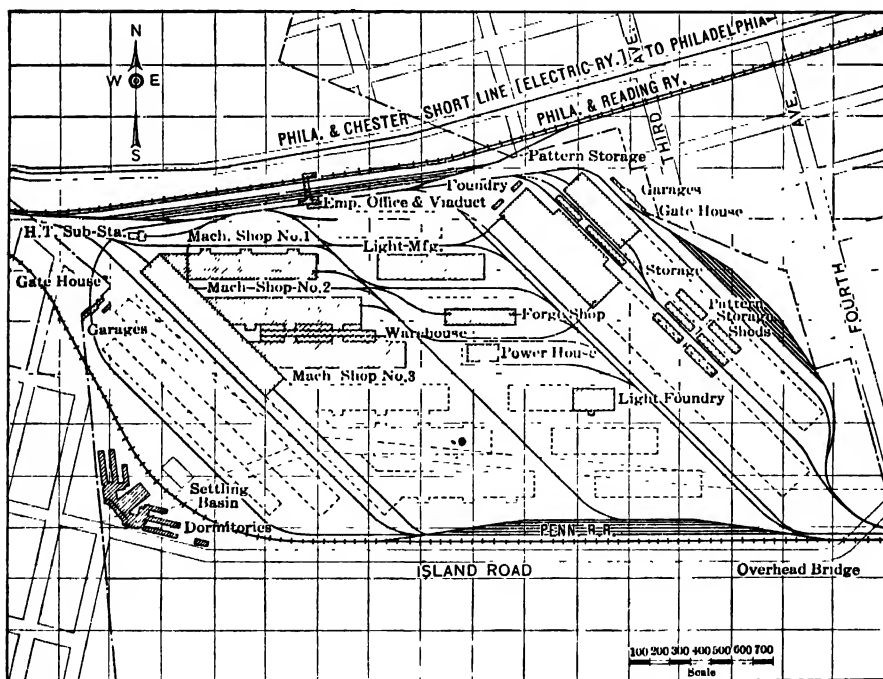
Courtesy Mathews Conveyor Company.

FIG. 29.—Loading Freight Cars at the Plant of Shredded Wheat Company, Niagara Falls, N. Y.



Courtesy Stone & Webster, Inc.

FIG. 30.—Interior Twin Cities Factory, Ford Motor Company. Note height of floors even with car door.



Courtesy Westinghouse Elec. & Mfg. Co.

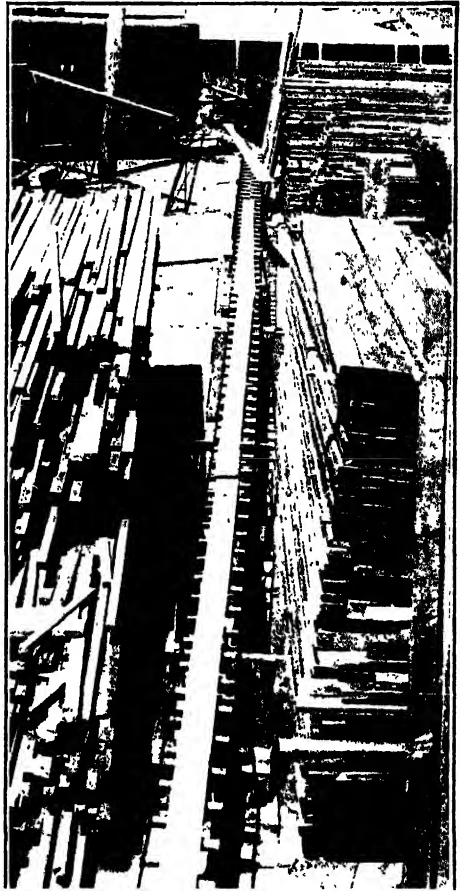
FIG. 31.—Layout of Westinghouse Electric & Manufacturing Co., South Philadelphia Plant, Lester, Pa.

materials and product in the storeroom have become an essential part of such departments during recent years. Not only do such devices save labor, but they allow the materials to be stowed to a greater height.

It is as a direct part of the manufacturing process that material handling has made the greatest strides during recent years. In the cement industry, and in flour mills, simple conveying devices have been an essential portion of the process for many years. The meat-packing industry was one of the first to use mechanical conveyors to support the product while operations were performed upon it. Such use of conveyors changes the process from an intermittent one to a continuous one, and makes for constant utilization of labor and equipment. (See Fig. 34.)

The rise of the automotive industry brought the opportunity to apply mechanical process conveying of materials on a large and varied scale. At the present time this industry does its processing, whenever possible, as the material moves on (see Fig. 27 and Chapter XLVI) and has applied mechanical handling to all phases of its material-handling problems (see Fig. 35). The moving-chain conveyor and its counterparts are the determining factor in the rates and costs of production in this industry. The lowering of prices and consequent enlargement of market which featured the use of process conveyors in the automotive industry came to be an outstanding development of manufacturing in the twentieth century, and served to make other industries endeavor to perfect production economies in the same manner.

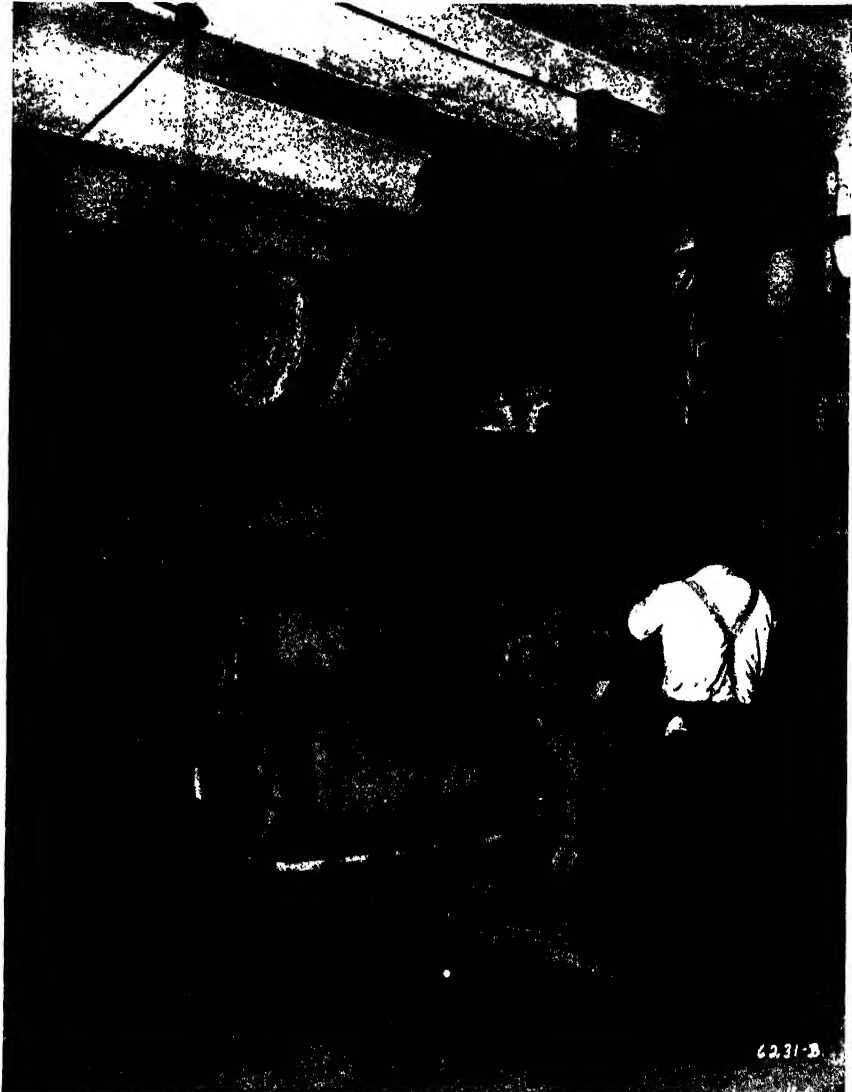
One of the older industries which has been revolutionized recently by



Courtesy, Matheus Conveyor Company.

FIG. 32.—Three Rail, Gravity Conveyor, Handling Lumber at the Mox Lumber & Wrecking Company, Los Angeles, California.

the use of mechanical handling equipment is the foundry industry. Older methods called for the use of much common labor here. Although com-



Courtesy Revolver Company.

FIG. 33.—A Tiering Machine.

mon labor has not been eliminated entirely, it has been greatly reduced. Figures 36 and 37 illustrate the application of process conveying in this industry. The bucket unit and storage hopper illustrated in Fig. 36



Courtesy Chain Belt Company.

FIG. 34.—Progressive Assembly and Conveyor at Maytag Company, Newton, Iowa.



Courtesy Chain Belt Company.

FIG. 35.—Conveyor Unloading Bodies at Chevrolet Motor Company Assembly Plant at Janesville, Wis.

are controlled by one man, who controls the storage and distribution of all molding sand. In the Studebaker Plant, Fig. 37, the molds come from the casting floor on the conveyor at the right. The pneumatic crane at the left lifts the flasks, dislodges the casting, and drops the sand



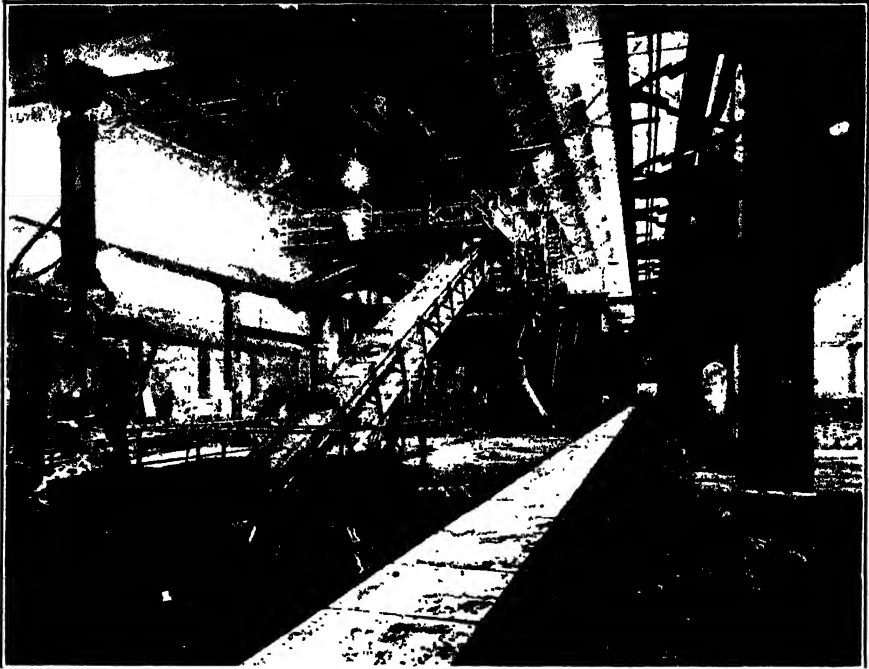
Courtesy The Cleveland Crane and Engineering Co.

FIG. 36.—Bucket Unit and Storage Hopper, Iron Foundry. Old sand is tempered and returned by conveyor to hoppers, then distributed to chutes above the molding machines by bucket units on a tramrail.

on the conveyor in the center of the picture, which takes it toward the storage bins. At the top of this latter conveyor is a magnetic separator which removes any particles of metal from the sand.

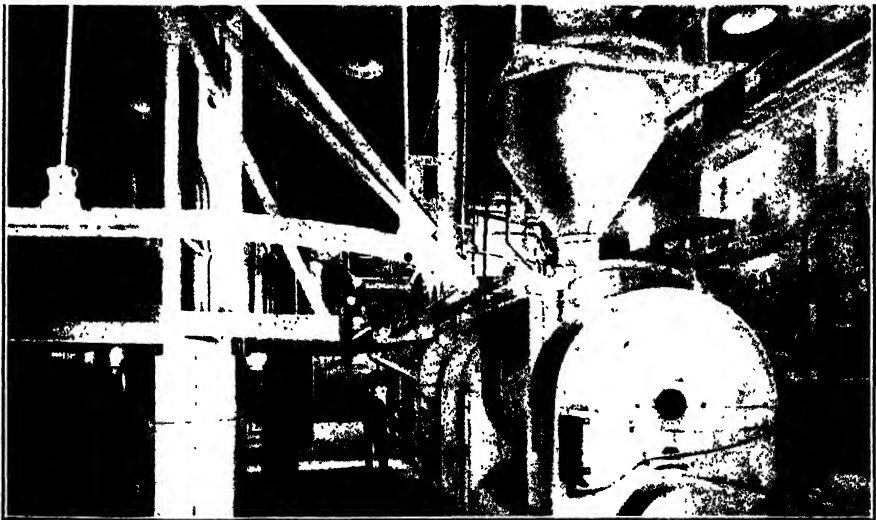
The application of the process conveyor in other industries is shown in Figs. 38 and 39. These illustrations need little explanation, other than Fig. 39, which shows the application in silk bleaching. The beam shown in this illustration is 120 feet long, and extends over ten vats, each approximately 12 feet in length. The silk must be dipped into each vat for approximately seven minutes. The beam is filled with racks containing the skeins of silk, and lowered into the vats, so that each load goes into its

respective vat. It remains in this position seven minutes, after which it is raised, and allowed to drain for two minutes. Immediately after draining, the entire load is moved forward one vat, and a new rack run on to the beam from the right side of the room. The silk skeins are supported on glass rods, which fit into the angle-iron sides of the racks. These



Courtesy Chain Belt Company.

FIG. 37.—Knockout Conveyor, with Knockout Bar Grating at the Left, and Mold Conveyor at the Right, Studebaker Corporation, South Bend, Indiana.



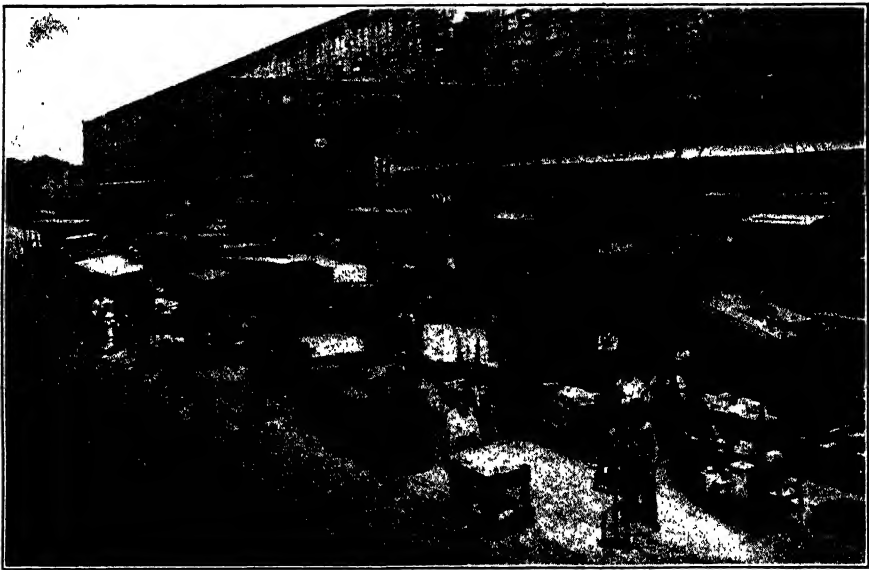
Courtesy The Cleveland Crane & Engineering Co.

FIG. 38.—Dough Trough about to be Dumped into Mixer after being Conveyed from Fermentation Room, Brown's Bread, Ltd., Toronto, Ont.



Courtesy The Cleveland Crane & Engineering Co.

FIG. 39.—Silk Dyeing by Mechanical Handling Equipment.



Courtesy General Electric Company.

FIG. 40.—Material Handling Equipment Assembled at Schenectady Plant of General Electric Company.

are turned over by the operator in this installation, so that the entire skein of silk is run through the bleach. In other types of installations, the material is turned by machinery. By this process, each skein of silk goes through exactly the same bleaching process, which would not be the case with hand methods. The beam is now being operated by one operator and four laborers, whereas formerly twenty men were required to do the work.

Although process conveying is the outstanding feature of material handling to-day, great strides have been made in other methods of handling materials that have not been mentioned specifically. Figure 40 illustrates clearly the large number of types of material-handling apparatus that are available for specific purposes. Material handling by modern methods is an important factor in the lowered production costs of mechanized industry.

CHAPTER XII

INDUSTRIAL LIGHTING

MODERN management differs from that of twenty years ago in many ways, but in none more than in the method of lighting the workplace. The spread of the doctrine of good lighting has been accompanied by enormous strides in the development of lights and lighting fixtures until the lighting of industrial buildings has been revolutionized. Research by the National Electric Light Association into lighting methods has been one of the outstanding contributions to industry in recent years.

Good lighting is necessary, not only from the production standpoint, but from the social standpoint. Since the modern industrial system forces so large a percentage of the community to utilize their eyes on close work, it becomes essential, from the standpoint of the health of the community, that there shall be some action taken to regulate lighting conditions in industry. Thus we find that all the more progressive states, including practically all the states with large manufactures, have laid down regulations for factory lighting. These regulations establish certain minimum lighting standards for factories and other workplaces. In many cases it has been found by the manager that he cannot always rely on the state standards, but must ascertain his own needs, and use the state standard as the minimum, only, below which he cannot fall.

Results of defective lighting. The results of defective lighting are numerous and rather easy to ascertain definitely. The cost of installing proper lighting is small. Oftentimes the cost of operating a defective lighting system is larger than the cost of operating a proper system. At any rate, the total cost of operating a good lighting system will seldom be over 2 per cent of the productive wages, and this is a small addition to overhead expenses. If a workman is hindered for one minute in an hour by defective illumination, the resultant loss will be sufficient to pay the complete cost for lighting his workplace for the hour. The following specific examples will illustrate this. At the Schenectady shops of the General Electric Company in one instance the bettering of illumination in a section devoted to semi-automatic buffing increased production 8.5 per cent. The increased cost of lighting amounted to 0.4 per cent of the increased value of production. An elaborate test was conducted in the plant of the Detroit Piston Ring Company. Starting with an initial

production of 12,000 piston rings per day under an illumination of 1.2 foot-candles,¹ the following changes were recorded:²

Foot-candles	Per Cent Increase in Production
1 2	
6 5	13
9 0	17
14 0	25.8

Defective illumination results in loss to the business in five ways: in accidents, loss of production, spoilage, effect on the general character of the workplace, and in the future capacity of the worker. The effects of poor illumination on the accident rate are too apparent to need much explanation. Failure to see dangers and failure properly to estimate their distance are both chargeable to defective illumination. A survey of 91,000 industrial accidents in 1910 from the records of the Travelers' Insurance Company showed that 23.8 per cent of these accidents were attributable to improper or inadequate illumination. Although there has been no exact survey since, this company now charges only about 10 per cent of industrial accidents to this cause, owing to the great improvement in industrial lighting since 1910. A large portion of this 10 per cent are accidents outside of buildings, along railroad tracks and in similar places, where even yet but little attention has been paid to illumination. This will be further discussed in Chapter XIV, on Industrial Safety.

The illustrations already given indicate the loss of production which comes through poor lighting. This is due to the fatigue attendant on eye-strain, and the resultant decrease in the productive "push." In addition to the quantity-production decrease attendant on defective illumination, a decrease in the quality of production is most usual. In some portions of the cotton-goods trade, particularly in England, cotton goods made in summer have demanded higher prices than winter goods, their quality being superior because of the better lighting conditions. Where the fine scales of micrometers must be read during production, lack of light is a frequent cause of slowing up production and perhaps of spoilage.

Defective lighting conditions increase the amount of spoilage. Experience and observation seem to indicate that of the huge amount of material spoiled in American factories, 75 per cent is spoiled during the time that artificial light is in use. Putting it another way, 75 per cent of the factory spoilage seems to occur during 15 per cent of the working year. Doubtless there are other factors which influence this loss besides the bad light, but apparently the large part of this loss could be prevented by

¹ A foot-candle is that unit of illumination intensity which is equal to the direct illumination given by a standard candle when placed one foot from the object illuminated.

² Data of Industrial Lighting Committee of the National Electric Light Association.

conditions during the after-dark hours which approximate those prevailing during the remainder of the day. This, of course, applies to plants which have good daytime, but poor artificial lighting. In many plants the reverse is the case. In fact there are cases where the workmen have requested to be put on night work, for, when working on piece rates, they could make more money under the better lighting conditions prevailing after dark.

The general character of the workplace, for instance, its cleanliness, has a direct result on the production that is secured. Good lighting has a direct effect on the cleanliness of the workplace and its maintenance in general all-round good condition. As a rule, a dark shop is also a dirty shop; a light shop is usually a clean shop. There is nothing so bad for dirt as plenty of light. Light, and especially sunlight, has a direct influence upon the destruction of various bacterial organisms, especially tubercle bacilli. Moreover, an abundance of light in a factory has an undoubted psychological effect upon the cheerfulness and well-being of the workers.

The last result of defective lighting that will be mentioned is the decrease in the future capacity of the worker. This is more intangible than the direct results mentioned, but is nevertheless just as real and in many respects more important. It is this result of defective lighting that furnishes the chief ground for state action. By driving workers under one of the many systems used to get immediate production, it may be possible for a plant temporarily to get full production from its workers with ineffective lighting. If the plant is lucky, it may have few accidents. When the worker's sight begins to fail, and the ills attendant to eye-strain begin to make themselves felt, the plant may then drop the worker from its payroll because of his inability to produce. It may thereby add some slight expense to itself, but it saddles a larger and more important expense on the community.

The effect of poor lighting on future capacity is felt in two ways—failing eyesight and general failure of health. Failing eyesight may take the form of mere decrease in the vision, or it may be that the defective lighting will cause eye diseases, such as the formation of cataracts. Workers on white goods, engravers, steel-makers, and others in similar occupations who work on materials reflecting glare, frequently suffer from eye lesions or the formation of cataracts. Headaches, backaches, anemia, and other defects in the general health of employees are directly traceable to defective illumination. Of course, poor illumination is usually only one of several poor factory conditions which cause this effect on general health, and therefore it is very difficult to trace the exact effect of poor lighting in this connection.

Effective use of natural light. The first step toward securing proper lighting conditions is to provide proper natural lighting during the day-

light hours. Natural light illuminates either by direct rays or by reflection from various surfaces outside or inside the factory buildings. Provision for natural lighting must take into account these reflections. The illumination given by daylight is general in that it is spread throughout the whole room. The color of natural light is pleasant for the eyes, and the only disadvantages of daylight are that it is not always uniform, that its intensity depends on seasons, time of the day, and conditions of the weather, that it is difficult to increase the amount of light available for local conditions and on special materials where greater intensity of light is necessary, and that the direct rays of the sun sometimes give too much glare.

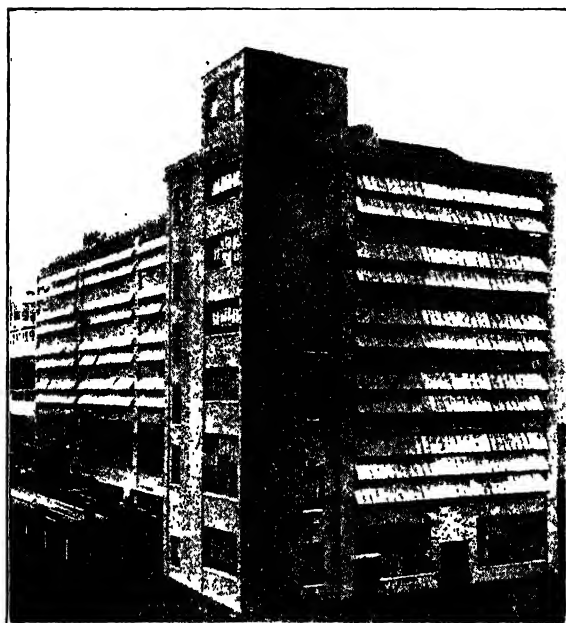
The provision of adequate natural lighting is directly related to the construction of the building itself. It is affected by such considerations as the nearness, character, and color of adjoining buildings, the height and width of the individual rooms, the provision of open courts in the layout of the plant, and the type of construction, in so far as that affects the amount of window space that can be secured. The nature of the adjoining buildings cannot usually be changed, and this is one reason why the suburban location may be preferred. However, the other factors can be modified by the manager. The amount of light in the interior of a room will largely depend on the relationship of the height of the room to its width and depth. The rays of light coming through the window fall at an angle, and reach only a certain distance from the window. If the depth or width of the room is too great, a large part of the room will not be reached by the rays coming through the window, and may remain wholly or partly dark. The height of the room is also of importance, because the higher the room is, the greater will be the quantity of light admitted, provided the top of the window is near the ceiling.

It is evident that industrial establishments should have as large a window space as is possible. It has been found that poor lighting will result if the ratio of floor space to window space is greater than six to one. In most modern "daylight" factories the window space will be found to be from one-third to one-fifth as large as the floor space. Such buildings are illustrated in Figs. 41 and 42. •

Daylight buildings cost money, but they are worth it. Large window areas cost more than solid construction. Cost of heating is increased, because heat losses radiated through glass are many times greater than those through solid walls. Originally such buildings were not air-tight, but now they are very nearly so.

One of the earliest means of providing sufficient natural light was by utilizing the "saw-tooth" roof for one-story structures. (See Fig. 16.) This was not ordinarily applied to top floors of multi-story buildings and fell somewhat into disrepute because of the difficulties of heating and ventilation, since corrected, which accompanied early saw-tooth roof

installations. Newer factories began to "daylight" their buildings through the use of steel window sash which occupied nearly the whole sidewall of the building. (See Figs. 20, 41, and 42.) Steel windows can be adjusted easily to distribute fresh air and daylight to the interior of the building; they can be made fire-resisting by the use of fire-glass; and they



Courtesy David Lupton's Sons Co

FIG. 41.—A Daylight Factory, Firestone Tire & Rubber Co., Mechanical Building, Akron, Ohio.

present straight lines which are architecturally correct for the industrial building of to-day. At present many factories are combining the use of steel-frame windows with top-floor saw-tooth roofs or adaptations of these. Thus the B. F. Goodrich Company of Akron, Ohio, has a large assembly room in their rubber-shoe plant located on the top floor under excellent top light as well as side light, while those operations which do not require such excellent light have been placed on the lower floors.

Fourteen 70-foot lines of window lights in this roof and three 140-foot lines are operated simultaneously by electric control. In cigar factories, where colors of cigars are matched by natural light, this important process is placed on the top floor under saw-tooth roofs.

Ventilation difficulties with saw-tooth roof construction have been overcome in newer types of this roof and also by the use of the double saw-tooth roof with window space in two sides instead of one.

The type of window glass is also an important factor in the development of the natural lighting system. It has been found that the loss of light through ordinary sheet glass is about 4 per cent. Ribbed glass causes the loss of about twice as much light, but this loss is counter-balanced because the rays of light, instead of falling directly on the floor, may be refracted and directed more nearly horizontally further into the interior of the room.

Only in recent years has proper attention been given to the painting of factory interiors. A paint will reflect or absorb light, depending on its color and quality. Flat-tone paints will absorb, while enamel paints will reflect. The reflection factor varies with the color and shade:

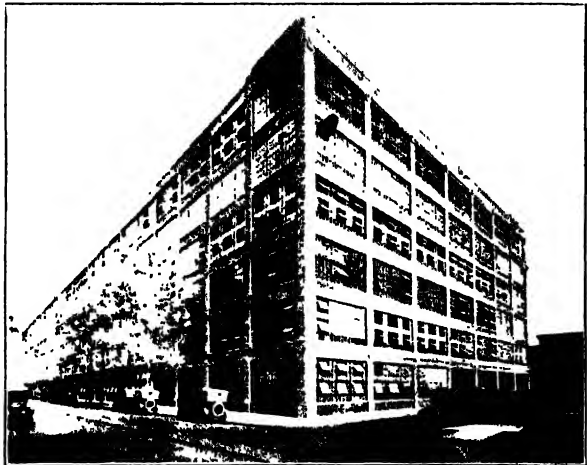
Absorption, Per Cent	Enamels	Reflection, Per Cent
18	White	82
25	Ivory	75
30	Light Gray	70
35	Buff	65
40	Light Green	60
55	Dark Gray	45
85	Brown	15

Such wall surfaces as may be before a workman's eyes constantly, especially if strong daylight falls upon them, should be painted with colors that will not reflect glare into the worker's eyes. Some plants mix green or blue with white in applying such paint. Both natural and artificial light is re-reflected within a room several times, and therefore the ceiling of the room is an important light-reflecting or absorbing factor. The modern factory now sees that its maintenance staff maintains the walls and ceilings in the same manner that it maintains any of the machinery in condition.

Importance of artificial light. Artificial light must be provided as a continuous supplement to daylight in places where the latter is insufficient, to provide for lighting after

dark during regular working hours in winter, for night work, and for outdoor lighting at night. The minimum time that a normal industry will use artificial light during the year is 20 per cent of the total working hours. To this must be added that use which is constant when daylight cannot reach a workplace adequately.

Intensity of illumination. Sufficiency of illumination can be mea-



Courtesy David Lupton's Sons Co.

FIG. 42.—One of the Daylight Factories of the Fisher Body Corp., Detroit, Mich.

sured in foot-candles by a simple device, the foot-candle meter. The amount of illumination intensity which is needed varies with the type of business, the type of operation, the type of material being worked on, and the environment. In general, the following figures represent the intensity necessary:

	Foot-candles
Stairways, passageways, and corridors	2 to 5
Rough manufacturing, such as filter-presses and grinding rooms in potteries, vat-rooms in tanneries, rough forging, beating in paper mills, etc.	3 to 5
Medium manufacturing, such as rough machining, making light-colored paper boxes, core making in foundries, etc.	4 to 8
Fine manufacturing, such as automatic machines, spinning, weaving, fine assembling	6 to 12
Very fine manufacturing, such as watch manufacturing, linotype operation, inspecting and sorting dark material	10 and up
General office work	10 to 12
Drafting rooms	15 to 18

Work is of two broad classes, inspective and detective. Inspective work will require the maximum named in the range of foot-candles. Such work is that requiring continuous application of the eye to one small point or area. Detective work will only require the minimum named. It consists of keeping general watch over the progress of a given process.

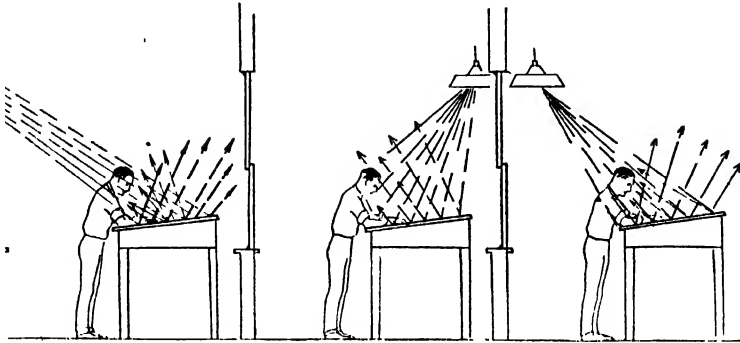
Light and dark materials fall into different ranges of intensity.

Dark and rough surfaces absorb much more and reflect much less light than do smooth, light ones. Similarly, the amount of light required will be affected by the machinery that is used. Machinery that is painted black will absorb a great amount of light. Machinery that is painted gray will not cause undue reflection of light where it is not wanted, and at the same time will not absorb nearly so much light. The difference in a machine shop with many machines if the machinery is painted gray rather than black is quickly noticeable, and black-painted machinery is rapidly passing.

Glare and reflectors. Glare is of two kinds, glare from the source of light, and glare of reflection from bright surfaces. In either case it is light out of place. Figure 43 indicates the manner in which the proper placing of light sources and proper type of reflector will eliminate the glare of reflection. Glare arises from improper diffusion, from the source of the light being intrinsically too brilliant (more than about $2\frac{1}{2}$ candles per square inch), and from the angle between the light, the work, and the eye being too small (less than about 30 degrees).

The source of light is but raw material to work with in the provision of proper light and the elimination of glare. It is the dome or reflector that turns this raw material into adequate illumination. Some reflectors are

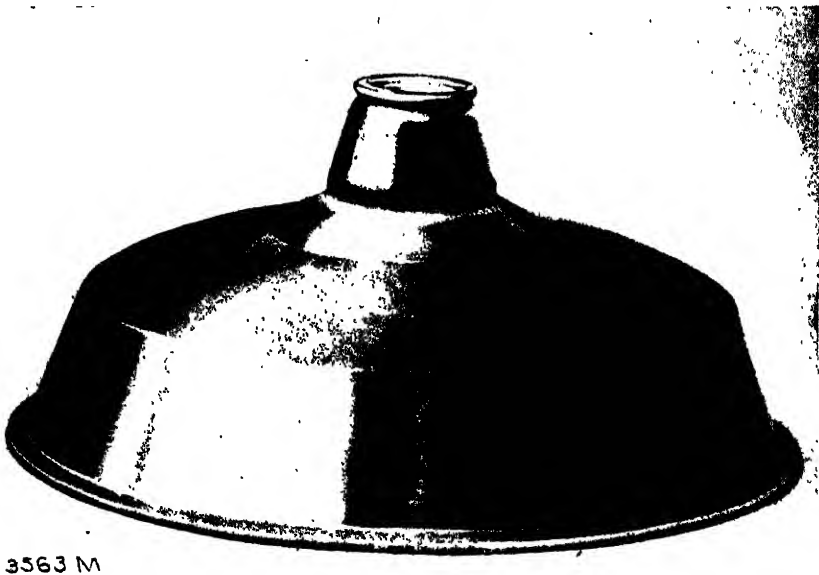
of the indirect type; some of the opal, semi-indirect type; some of enclos-



Courtesy Edison Lamp Works.

FIG. 43.—Effect of Changes in Placing Light Outlets with Proper Reflectors.

ing glass; some prismatic; and some of enameled steel. The type most used in factory installations is the R L M type illustrated in Fig. 44.



Courtesy National Lamp Works.

FIG. 44.—R L M (Reflector and Lamp Manufacturers') Standard Dome.

This reflector, which was devised after many tests, is the one used in all the computations on the following pages.

Special reflectors must be used under unusual conditions. Deep bowl reflectors must be used where a deep shielding angle is required to eliminate glare from the lamp filament, for instance where the mounting height is low, less than 8 feet above the floor. For all elevations up to 20 feet it is best to use a bowl-enameled lamp; above that clear lamps may be used. Reflectors of milk glass or with bottoms of this material are used where elimination of all shadows is absolutely essential, as in office or drafting-room work.

The background of an operation may be neglected in planning the lighting, and glare may result. In the inspection department of a hosiery mill an intensity of 22 foot-candles was adopted. The tables were finished in white enamel "to improve the light reflection." The hose inspected were dark-colored, and it was the practice of the workers to place a stack of hose on the table to be examined for flaws. The operators complained that there was not enough light provided. The trouble was not an inadequate supply of light, but rather a disregard of the need of having the background darker than the object under inspection.

Color of light. Artificial light must be of pleasing color, and in some operations daylight color is necessary. Some of these operations are grading sugar or tobacco, sorting tin-plate, tempering steel, and matching colors in textile mills. Special lamps are to be had which approximate daylight in color. There are some operations, as finishing bodies in automotive plants, where clear definition of the conditions of the surface is the important feature of the light to be provided. In such cases, mercury vapor-tube lights are used for this purpose, because of the excellent diffusion secured. These lights are not of a pleasing color, but are used because of their other properties.

Diffusion. Uniform diffusion of the light ranks with sufficient intensity as one of the prime essentials of proper lighting. The measure of effectiveness of a lighting system is not the brilliance of the source, nor of the object illuminated; but the ability of worker to distinguish clearly and differentiate easily without eye-strain. Extreme brilliance improperly diffused only tends to tire and confuse the vision. The essentials in this respect are the avoidance of irritating brilliancy or obscurity, the confusing shadows of which are usually a result of the former condition. All portions of the room must be illuminated; there cannot be any dark spots which the eye will see and contrast with the brilliant spots where light fails.

Adequate diffusion makes possible ease of discernment of any object, or portion of an object in any plane, horizontal or vertical. Although large areas of dark shadow must be eliminated, entirely shadowless illumination is not to be desired. Shadowless objects are flat and not normal to the eye.

Shadows are influenced by the spacing and the hanging height of the

lighting units. A broad, spreading cone of light, such as is produced by the R L M reflector, allows a lower mounting height than reflectors which concentrate light within narrow cones.

That lights should be safe and should discharge as few impurities into the air as possible, are two self-evident facts. The difficulty with many gas installations is that they develop vapors and fumes which materially injure the condition of the air in the room. This is overcome in a measure if there is a good ventilating system installed. Still, good lighting should be made possible without paying any special attention to other features of factory operation, such as ventilation.

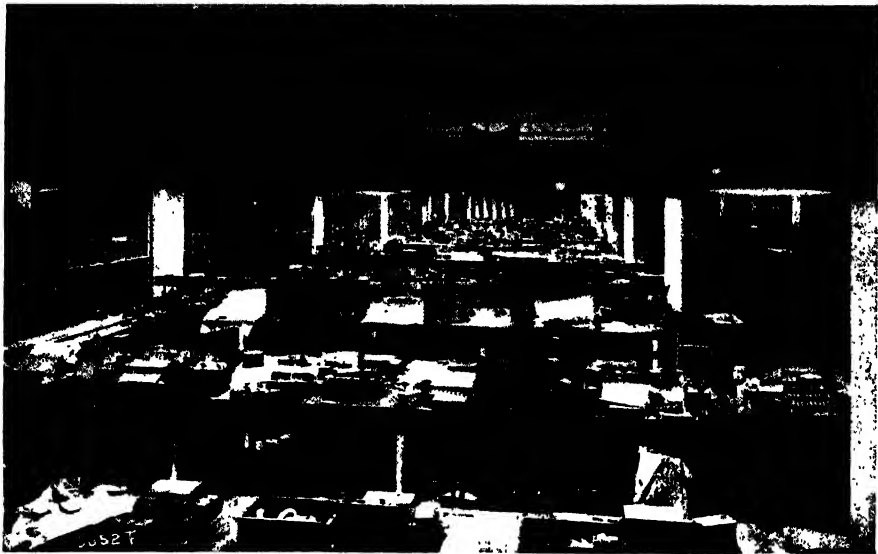
The electric filament light is now standard for industrial illumination. Some installations of gas lighting are still being made, particularly near natural gas fields where gas is cheap; but there is no question that electric lighting, with its ease of control, is the best available.

Most of the recent development work of illumination engineers has been in the utilization of filament lamps. With the increase of capacities which has been effected, with the betterment of the technique of light distribution, through the use of better reflectors, and with other similar advances, the filament lamp has gradually replaced other types of electric units.

Methods of arranging artificial lighting sources. In installing lighting systems there are several methods of arrangement which may be employed. They are each individually suited to particular conditions, but combinations of them are often made. The methods employed are (1) general lighting, (2) group lighting, and (3) local lighting. The most frequent combination of these is that of general and local lighting.

With the growth in lighting research, equipment has been provided that makes general illumination the method most used. This is gained through the use of comparatively large units placed near the ceiling, giving an illumination of approximately equal intensity throughout the whole workroom. It is especially suited to large, high, open workrooms, and to miscellaneous work where a general distribution of light is more necessary than a local centralization of light in special places. An example of such conditions is found in Fig. 45. General lighting, properly spaced, gives an even diffusion of light under the most adverse conditions, as is illustrated in Fig. 46, which shows an absence of shadows, even though there is a forest of belts in the room. A comparison of this illumination with Fig. 47 clearly indicates that local lighting alone, under these conditions, makes for glare and low average intensity.

Group lighting, or, as it is often called, localized general lighting, consists in lighting a particular group of machines, or particular area, by light units which are so placed with reference to the work as to illuminate it from the best direction. This type of lighting is particularly suitable



Courtesy National Lamp Works.

FIG. 45.—General Lighting. Assembling small parts for adding machines—200-Watt Mazda C Lamps, 9½ feet above floor. The sharp shadows suggest the possibility of improvement through the use of bowl-enameled lamps.



Courtesy National Lamp Works.

FIG. 46.—Screw Machine Room—"After." General lighting, 11 feet above floor, 100-Watt lamps, illumination 6 foot-candles.

for large rooms with many machines of the same type, performing such operations as spinning, weaving, buffing, etc. The distinguishing difference between general lighting and group lighting is that in the former the room itself is lighted without reference to the location of the work, while in the latter the lights are always placed with reference to the particular location of the work. Group lighting is growing in favor and is being successfully applied to classes of lighting in which formerly only local lighting was successful.



Courtesy National Lamp Works.

FIG. 47.—Screw Machine Room “Before.” Local lighting at irregular distances and heights. Average illumination 0.2 foot-candle.

Local lighting consists of the illumination of a single machine or portion of a machine with light which is specifically directed to the point at which illumination is most needed. Such lighting is used on work benches, lathes, sewing machines, or any class of work where a light may be needed from a nearly horizontal direction, or where a high intensity of illumination is required over a small area. Many errors have been made in the name of efficient local lighting. Local lighting gained favor in days when there were no large lamps or ceiling reflectors available, and when general illumination could not be felt through the belts that were driving the machinery then. Drop-cords were the standard method of getting local lighting to the desired point at that time, and have persisted in some plants until now. Modern lighting installations have eliminated drop-cords, not only because of their unsightliness, but because of the danger from their becom-

ing worn, and have replaced them with fixtures such as that illustrated in Fig. 48.

It is with local illumination that the greatest care must be taken to guard against glare from reflection, as the source of light is so close to the machine and the material being worked upon. Local lighting can never be used alone, but must be combined with general or group illumination. In the illustration, a 15-watt lamp is used for the local unit, and this gives an illumination intensity of 35 to 40 foot-candles at the needle, but



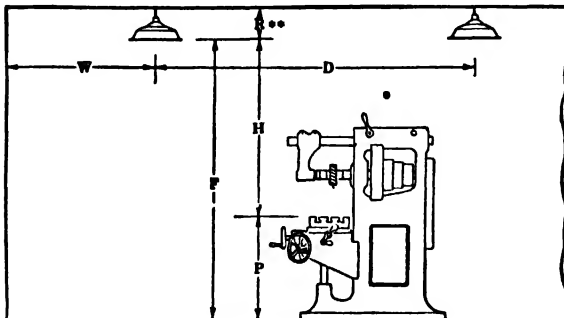
Courtesy National Lamp Works.

FIG. 48.—Effective Local Illumination.

this is supplemented by general lighting which gives an illumination of about 8 foot-candles in the room. Unless the general illumination be considerable, the relative darkness of the room as a whole, as contrasted with the brilliance of the workplace, will result in extreme eye-strain. Local lighting frequently gives adequate illumination in cases where it can be secured by no other method, for instance, if there is an inside cut being made on a lathe.

Spacing of outlets. At times the structural features of the room, for

Mounting Height of Unit		Permissible Distance between Outlets	Permissible Distance between Outlets and Sidewalls	
Above Plane of Work (H)	Above Floor* (F)		In Usual Locations where Aisles and Storage are Next to Wall (W)	In Offices or where Work Benches are Next to Wall (W)
4	6½	6	3	2
5	7½	7½	3½	2½
6	8½	9	4½	3
7	9½	10½	5	3½
8	10½	12	6	4
9	11½	13½	6½	4½
10	12½	15	7½	5
11	13½	16½	8	5½
12	14½	18	9	6
13	15½	19½	9½	6½
14	16½	21	10½	7
15	17½	22½	11	7½
16	18½	24	12	8
18	20½	27	13½	9
20	22½	30	15	10
22	24½	33	16½	11
24	26½	36	18	12
27	29½	40½	20	13½
30	32½	45	22½	15
35	37½	52½	26	17½
40	42½	60	30	20



*Plane of work (P) assumed to be 2½ feet above the floor. When the plane of work is higher or lower than 2½ feet above floor, neglect column (F) and work from column (H).

** Minimum allowance for (R) usually 1 foot.

Courtesy National Lamp Works.

FIG. 49.—Charts for Determining Proper Spacing between Outlets and Proper Mounting Height above Work or Floor.

instance, the presence of pillars, will influence the spacing of outlets for illumination. In such cases, each section between pillars must be treated as a separate room.

The accompanying chart, Fig. 49, prepared by the National Lamp Works, may be utilized to determine spacing between outlets.

Lumens. A lumen is a measure of the quantity of light. One lumen will illuminate one square foot of area to an intensity of one foot-candle. The floor-area of any room can be determined readily, and this, multiplied by the desired foot-candle intensity, gives the number of lumens which must be effective or must reach the work. It is apparent that all of the light emitted from the lamp does not reach the plane of work. Reflectors are used to direct as many as possible of the lumens emitted from the lamp to the plane of work. Since there is no perfect reflecting surface, all reflection is accompanied by absorption and loss of light. The coefficient of utilization of lumens emitted depends, first, on the type of reflector; second, on the proportions of the room; third, on the color of the surroundings; and fourth, on a depreciation factor based on the rated life of the lamps and the maintenance conditions. Therefore:

$$\text{Total lumens} = \frac{\text{Square feet} \times \text{foot-candles}}{\text{Depreciation factor} \times \text{utilization constant}}$$

After the total lumens have been found for any room, the lumens needed per lamp may then be found by dividing the total lumens by the number of outlets as determined from Fig. 49. All electric light companies have tables giving indexes for room proportions, coefficients of utilization, and approximate depreciation factors. The following sum-

LAMP DATA—MAZDA C LAMPS

110, 115, and 120 Volts									
Watts	50*	60*	100*	150	200	300	500	750	1,000
Lumens, per watt	10.8	11.1	13.2	15.2	16.1	17.4	18.8	19.7	21.0
Total lumens	540	660	1320	2280	3220	5220	9400	14,770	21,000

Mazda Davlight Lamps									
Watts	60*	100*	150	200	300	500			
Total lumens (Approx.)	430	870	1500	2100	3400	6400			

* Inside frosted.

FIG. 50.

ples from such tables are presented to indicate the method used to determine proper size of lamps for an installation.

Figure 50 gives the emitted lumens from certain sizes of Mazda lamps. Figure 51 gives room proportions and room indexes. Figure 52 gives coefficients of utilization. The depreciation factor may be set at 0.75.

ROOM INDEX FOR ORDINARY ROOMS

		Feet	Feet	Feet	Feet	Feet	Feet	Feet
For indirect lighting use ceiling height . . .		9-10	10-12	12-14	14-17	17-20	20-24	24-30
For direct lighting use mounting height . . .		7-8	8-9	9-10	10-12	12-14	14-17	17-20
Room Width, Feet	Room Length, Feet	ROOM INDEX						
20-24	20-30	2.5	2.0	1.5	1.2	1.0	0.8	0.8
	30-42	2.5	2.0	2.0	1.5	1.2	1.0	0.8
	42-60	3.0	2.5	2.5	2.0	1.5	1.2	1.0
	60-90	4.0	3.0	3.0	2.5	2.0	1.5	1.2
	90-140	5.0	4.0	4.0	3.0	2.5	2.0	1.5
	140-up	5.0	5.0	4.0	4.0	3.0	2.5	2.0
24-30	20-30	2.5	2.0	2.0	1.5	1.2	1.0	0.8
	30-42	3.0	2.5	2.0	1.5	1.5	1.2	1.0
	42-60	3.0	3.0	2.5	2.0	1.5	1.2	1.0
	60-90	4.0	4.0	3.0	2.5	2.0	1.5	1.2
	90-140	5.0	5.0	4.0	3.0	2.5	2.0	1.5
	140-up	5.0	5.0	5.0	4.0	3.0	2.5	2.0
30-36	30-42	3.0	3.0	2.5	2.0	1.5	1.2	1.0
	42-60	4.0	3.0	3.0	2.5	2.0	1.5	1.2
	60-90	4.0	4.0	3.0	3.0	2.5	2.0	1.5
	90-140	5.0	5.0	4.0	4.0	3.0	2.5	2.0
	140-180	5.0	5.0	5.0	4.0	4.0	3.0	2.5
	180-up	5.0	5.0	5.0	5.0	4.0	3.0	2.5
36-42	30-42	4.0	3.0	2.5	2.0	2.0	1.5	1.2
	42-60	4.0	4.0	3.0	2.5	2.0	1.5	1.2
	60-90	5.0	4.0	4.0	3.0	2.5	2.0	1.5
	90-140	5.0	5.0	5.0	4.0	3.0	2.5	2.0
	140-200	5.0	5.0	5.0	5.0	4.0	3.0	2.5
	200-up	5.0	5.0	5.0	5.0	4.0	4.0	3.0

Courtesy Edison Lamp Works.

FIG. 51.

Probable Average Illumination in Per Cent of Initial Illumination			Ceil- ing	Very light, 70%			Fairly light, 50%			Fairly dark, 30%	
Clean Con- di- tions	Average Con- di- tions	Dirty Con- di- tions	Walls	Fairly light, 50%	Fairly dark, 30%	Very dark, 10%	Fairly light, 50%	Fairly dark, 30%	Very dark, 10%	Fairly dark, 30%	Very dark, 10%
			Index Room	COEFFICIENTS OF UTILIZATION							
85	80	70	0 6	.32	.28	.25	.32	.28	.25	.27	.25
			0 8	.40	.36	.34	.39	.35	.33	.35	.33
			1 0	.43	.39	.37	.42	.39	.37	.39	.37
			1 2	.46	.43	.41	.45	.43	.41	.43	.41
			1 5	.48	.45	.43	.47	.45	.43	.45	.43
			2 0	.52	.50	.48	.51	.49	.47	.49	.47
			2 5	.56	.54	.52	.55	.53	.51	.53	.51
			3 0	.57	.55	.53	.56	.54	.52	.54	.52
			4 0	.60	.58	.56	.59	.57	.55	.57	.55
			5 0	.61	.59	.57	.60	.58	.57	.58	.56

Courtesy Edison Lamp Works.

FIG. 52.

Coefficients of Illumination, Using R L M Dome Reflector and White Bowl or Inside Frosted Lamp.

Example of calculation of lighting installation. In a room 40×120 feet, with work on automatic machines, with no work near windows, and no columns in the room, the ceiling height is $10\frac{1}{2}$ feet, and the mounting heights of the lighting units $9\frac{1}{2}$ feet. The ceiling is white, and the walls are about 50 per cent windows. There is little reflection of artificial light from window glass, and hence the walls may be considered as being fairly dark.

The table on page 132 indicates that 6 to 12 foot-candles are necessary for automatic machinery. Assume the use of 10 foot-candles. Figure 49 indicates that with the mounting height of units $9\frac{1}{2}$ feet, they may be not more than $10\frac{1}{2}$ feet apart. In this room, therefore, there would be four rows of outlets 10 feet apart and 5 feet from the walls.

Reference to Fig. 51, Room Index, indicates that the index for this room is 5.0. Reference to Fig. 52 indicates that the coefficient of utilization with R L M reflectors, light ceiling, and fairly dark walls is 0.59. The depreciation factor may be assumed as being 0.75. Hence from the formula above:

$$\text{Total lumens} = \frac{4800 \times 10}{.75 \times .59} = 108,475.$$

With outlets at 10-foot centers, there would be 48 outlets, or need for 2260 lumens per outlet. From Fig. 50 it will be evident that this installation will require 150-watt lamps.

Maintenance of lighting installations. A consideration of continuing importance in lighting installations is maintenance. It makes no difference how effective the system may be when first installed; if it is not kept up to the standard which was set in the first instance, it will be of no enduring value. In the example just given, a depreciation value of 0.75 was taken. This includes wear during the life of the lamps, and also dust on the reflector and lamp, which is normal even with good maintenance. But a few weeks' neglect may cause the effectiveness of the system to drop below 50 per cent of normal. The maintenance of the lighting system should include a systematic plan for keeping the lamps and reflectors in a clean and otherwise suitable state. When lamps deteriorate so that their effectiveness has become reduced, they should be replaced immediately. This involves accurate knowledge of the amount of light at given points at regular intervals. This information may be secured the use of the foot-handle meter. There is a general tendency to continue lamps in service far past the point where the installation of new lamps would be profitable. The maintenance of the lighting system should be definitely placed in the hands of one member of the organization. This man may or may not be the one who had charge of the lighting installation in the first instance. Either the works engineer, who has to do with general maintenance, or the safety engineer may be the man.

CHAPTER XIII

INDUSTRIAL AIR CONDITIONING

THAT air conditions within a factory are important from the standpoint of production is well known. What the quantitative effect of poor air conditions is on the production of factory workers is not at present so well known. However, studies already made by Dr. Ellsworth Huntington¹ and others, on the effect of the atmosphere on man in different parts of the world, make it certain that there is a direct reduction of output, as well as increased absence due to illness caused by poor air conditions within a factory. It is merely necessary to contrast the feelings of an individual on a hot, muggy August day and on a cool, bright fall morning to understand that energy, and hence work done, is somewhat dependent on atmospheric conditions. Because of ineffective heating and ventilation systems, many a factory worker is kept at an August production level by an August atmosphere in his workroom during the winter.

Effects of poor air conditions. The effects of poor industrial air conditions may be divided into the effect on the employees, the effect on the material, and the effect on the equipment. The effect on the employees, as already suggested, may result in a direct decrease in production on account of a decrease in the worker's effectiveness, or may result indirectly in decreasing production because of illness among employees. Although the amount of direct decrease in production cannot be stated with any degree of assurance, nevertheless it is only necessary to observe factory conditions in certain plants to know that there is considerable decrease in productive effectiveness. For instance, in some paper mills, dye houses, and hat factories where air conditioning has been given little or no attention, water from the steam used in the process condenses during the winter months and drops down on the workers and the work in a way that resembles rain. So great is the condensation of moisture in the sizing room of one hat factory that the workers have uniformly provided themselves with umbrellas under which they perform their duties.

What are poor air conditions? That poor air conditioning causes illness is fairly well demonstrated. One company put up a modern industrial plant without giving much consideration to good ventilation and had

¹ "Civilization and Climate," by Ellsworth Huntington. Yale University Press.

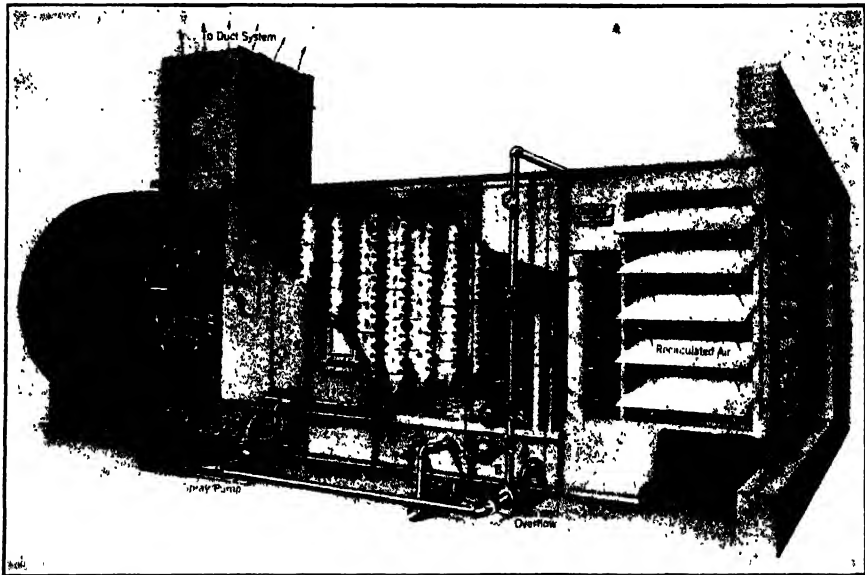
27½ per cent of its employees ill during each of the first two winters. A ventilation system was installed and this percentage was reduced to 7. Such a change is due to a number of the factors in the air condition. Some of those which have been looked upon as most important in the past are, in reality, of no great moment. For instance, the decrease in the percentage of oxygen, which has frequently been regarded as important has, after test, except in the most crowded factory workrooms, proved to be so small as not to be worthy of mention. The increase in CO_2 , carbonic acid gas, which is important if large, is ordinarily found to be of no great moment since, except in the most crowded workrooms, the increase is but slight. The increase in volatile organic products, possibly including infectious bacteria, in the air, is of such importance that it has been demonstrated that factory air should be either changed periodically or should be washed if the same air is reutilized. Frequently the addition of gases and fumes due to the processes is sufficiently important to justify some special treatment for the ventilation of those rooms in which these processes are performed.

The most important factors in poor industrial air conditions are improper temperature and improper humidity, or a combination of these two. Approximately 3000 cubic feet of air per person per hour, of the right temperature and humidity, should be provided, and the air can be changed from three to five times an hour to give this amount of air per person without any feeling of draft in the room. The proper temperature of air in a factory workroom depends upon the operation and upon the humidity. If the operation be one involving hard manual labor, it may be that in the winter months a temperature of 55 degrees will be sufficient. The ordinary factory workroom can be held at 65 degrees and be comfortable if the humidity is correct. In the usual type of steam-heating system that is likely to be found in a factory, air which is 40 degrees in temperature on the outside is brought in and heated up to 70 degrees. Naturally, this dries the air and makes it absorb moisture from anything, particularly from the bodies of the workers in the room. This gives rise to the feeling of discomfort and irritation which is frequently found in factory workrooms during the winter months. Air at 75 degrees temperature and 20 per cent relative humidity is not as warm as air at 68 degrees temperature and 50 per cent relative humidity, or 65 degrees temperature and 65 per cent relative humidity. Of course humidity cannot be continually increased. Much of the discomfort of summer temperatures is due to the high humidity, and 70 per cent humidity is probably the maximum to which any air should be allowed to come.

Heating and ventilating systems. Older heating and ventilating systems provided for the use of radiators for heat along the walls and for the use of windows as a means of ventilation. This always resulted in non-uniform

temperatures, the windward side of the building being cold and the windows creating certain temperature problems because of the seepage of air usually occurring around them. The newer factory construction, involving as it does huge areas devoted to window space, has intensified the difficulties of conditioning air by the old methods in factories, since the large majority of the heat from radiators near windows is likely to be expended in keeping outside cold air from forcing its way in.

Modifications made in this method of factory heating and ventilation have involved the placing of humidifying saddles on the radiators. This has been, in the main, an unsatisfactory way of moistening the air in a



Courtesy The Carrier Company.

FIG. 53.—Air Conditioning Equipment.

room. The placing of humidifiers within a room where their presence was absolutely essential, as in weave sheds of textile mills, and the cutting of portholes back of radiators so that some new air would be coming constantly into the room for replacement purposes, are two more steps which have been taken. In one-story buildings such as foundries, ventilators in the roof worked by the suction power of wind, or double saw-tooth roof construction, have aided in changing the supply of air within the factory work-room and have proved particularly satisfactory where fumes or smoke are present.

Blower-type air-conditioning systems. The most satisfactory type of air-conditioning system involves the utilization of a blower or fan which

draws a fresh air supply into the building, and propels it through the building by means of ducts, the outlets of which are properly spaced and so constructed as to prevent the seepage of cold air through window surfaces. Such apparatus ordinarily provides for drawing the air supply through plates for cleansing purposes, and through water spray for humidifying purposes, and can be controlled so that any degree of temperature or humidity desired can be secured. An illustration of such apparatus will be found in Fig. 53. The method of distributing this air will vary with the type of building construction, as indicated by the illustration of the south yard machine shop heating system in the Camden, N. J., plant of the



Courtesy American Blower Company.

FIG. 54.—South Yard Machine Shop Heating System, American Brown-Boveri Corporation, Camden, N. J.

American Brown-Boveri Corporation (Fig. 54), and the illustration showing distributing ducts in the columns of the Crown Cork and Seal Co. (Fig. 55).

In spacious shops, such as that of the American Brown-Boveri Corporation, it is perfectly satisfactory to reutilize old air which has been heated, thereby saving considerable on the coal bill.

The effect of utilizing this type of air conditioning and distributing system is that air heated to the proper degree of temperature and in the proper degree of humidity is uniformly distributed to all portions of the factory building. The air changes constantly at low velocity and thereby

removes the film of air around the human body which always exists with poor ventilation. The system provides for an inside pressure in order to



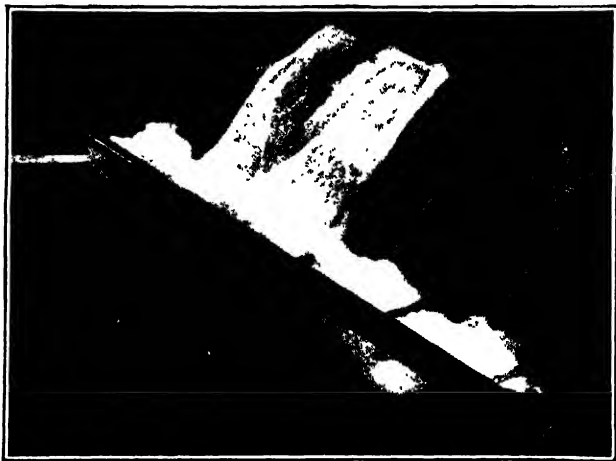
Courtesy American Blower Co.

FIG. 55.—Distributing Ducts for Heating System in Columns on Machine Shop Floor, Crown Cork & Seal Co., Baltimore, Md.

propel the air throughout the building. Thus all leakage is outward, preventing cold air coming through the windows with consequent increase in fuel bills. All dust and other foreign matter are eliminated from the air by the washing process which it goes through and, as a final advantage, the space near the windows where radiators would be found ordinarily, and which is most

valuable for productive work, because of lighting conditions, can be so utilized.

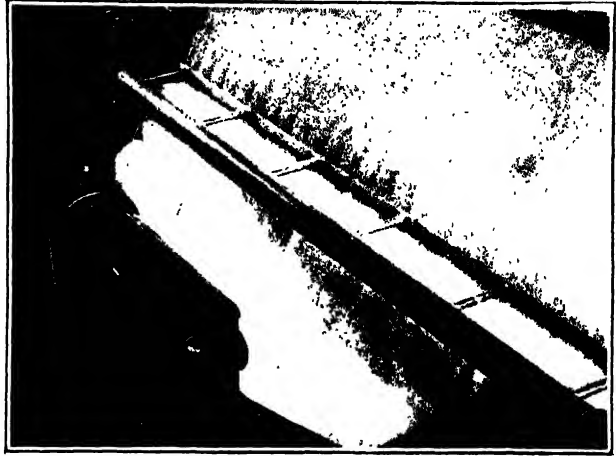
Many plants which have installed air-conditioning systems of this type found it very difficult to prevail upon employees to keep the windows closed. In fact, some plants have had to go so far as to nail their windows shut, and even then they frequently found in the summer time that employees had removed these nails, although theoretically the air conditions within the building were much more satisfactory than those on the outside. Experience has seemed to indicate that it is probably best,



Courtesy Parks-Cramer Company.

FIG. 56.—Difficulties in Starting the Card in a Dry Atmosphere. Static electricity causes cotton to cling to the doffer and the doffer comb.

where employee opposition against the keeping of the windows shut is faced, and where an educational campaign fails, to make no attempt to combat the psychology of the employee who desires to open the windows. It may be that this desire on the part of the employees to open the windows is due to the desire to have a change in atmospheric conditions. It is probable, based on researches made to date, that an error has been made in supplying strictly uniform air conditions at all times.

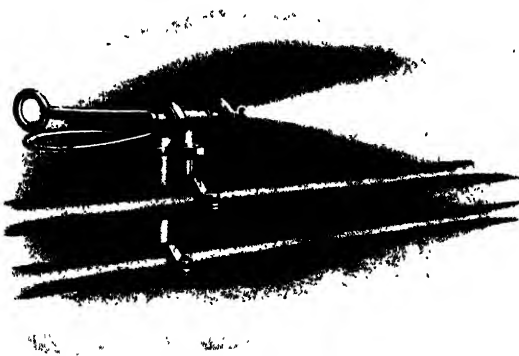


Courtesy Parks-Cramer Company.

FIG. 57.—Humidity Sufficient to Allay Static Electricity Prevents any Tendency for the Cotton to Cling to the Doffer and Comb.

Human beings

seem to thrive best in those sections of the world where temperature changes are constant and rapid. Whether this means that air and humidity conditions within the plant should be constantly changing cannot be determined until further investigations have been completed.



Courtesy Parks-Cramer Company.

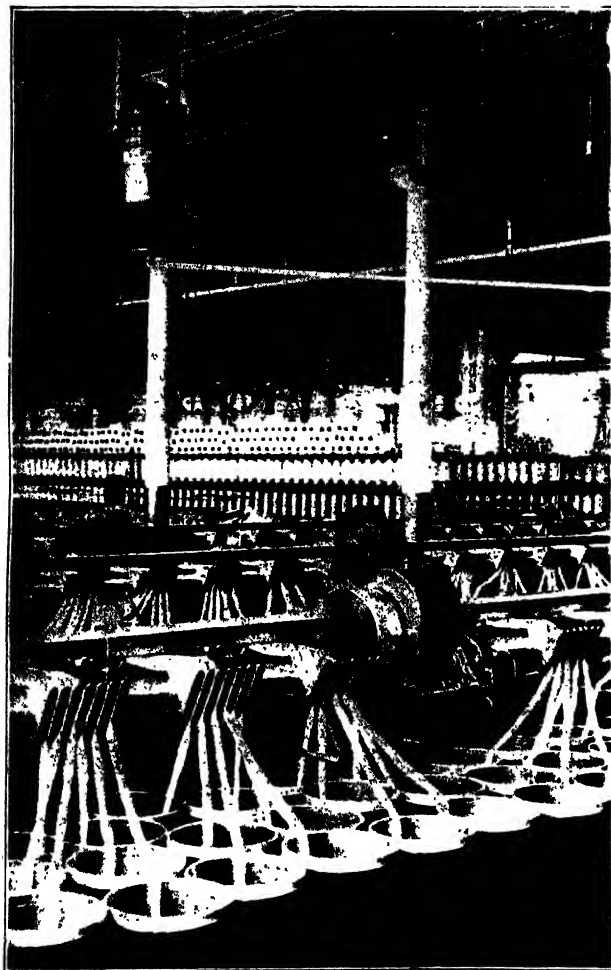
FIG. 58.—An Atomizer Humidifier. It relies on compressed air as the atomizing and distributing agency.

PROCESS AIR CONDITIONING

Effect of air conditions on material. Incorrect air conditioning in bakeries, textile mills, cabinet-working plants, and other industries,

makes difficult the proper working up of material and brings with it high production costs. In bakeries, unless certain conditions of temperature

and humidity are maintained, the dough may be coarse or sour, and its rising is not uniform. A flat loaf is caused by too little humidity. Loaves with large air bubbles in the center are caused by varying humidity and temperature. In textile mills, it is essential that moist air conditions be

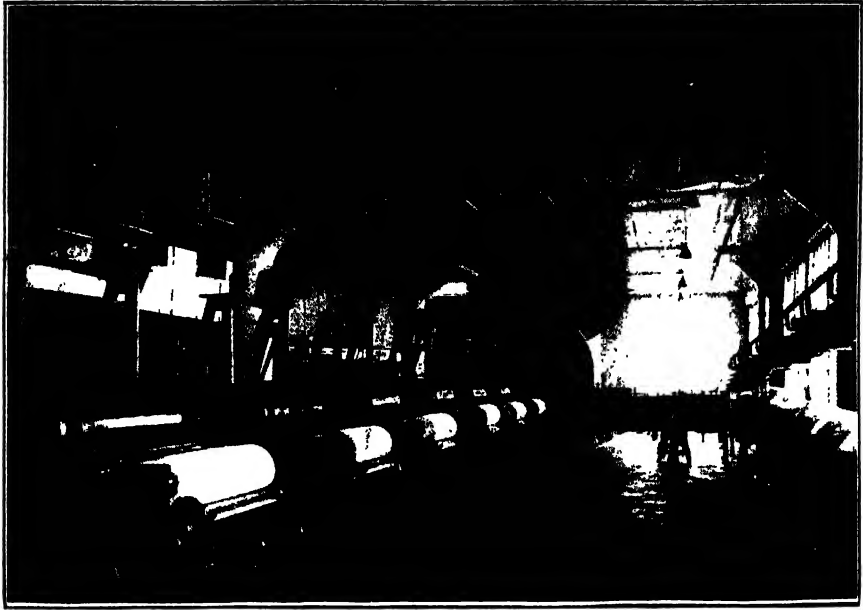


Courtesy Parks-Cramer Company.

FIG. 59.—Cotton Drawing, Utilizing Individual, Spray Humidifiers.

present. (See Figs. 56 and 57.) This was the original cause of the textile mills of New England locating near the foggy seacoast. If there is too little humidity in the atmosphere, the yarn becomes very dry in weaving, and snaps, thus necessitating frequent stoppage of the loom and knotting of broken threads. If the humidity is too great it affects the texture of the yarn, causing it to swell unevenly and making a poor grade of goods. Cabinet-making plants, where veneering is used, also have less trouble with their raw material when it is worked up under proper temperature and humidity conditions.

Effect of air conditions on machinery. Air can either be too damp or too dry with respect to the machinery in a plant, particularly in the case of fine machinery, such as that used in hosiery mills. If the air be too damp the machinery rusts and the parts drag. If the air be too dry, static



Courtesy The Carrier Company.

FIG. 60.—Air Conditioning in the Carding Room, Jackson Mills, Nashua, N. H.
Central system.



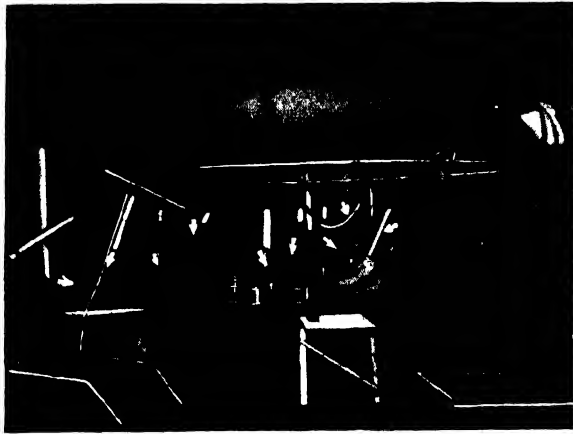
Courtesy The Carrier Company.

FIG. 61.—Process Air Conditioning in Roving Operation, Jackson Mills, Nashua, N. H.
Central system.

electricity is created, which hampers the operation of the machines. These requirements of material and equipment must be thought of

at the same time that the effect of air conditions on the workers is considered.

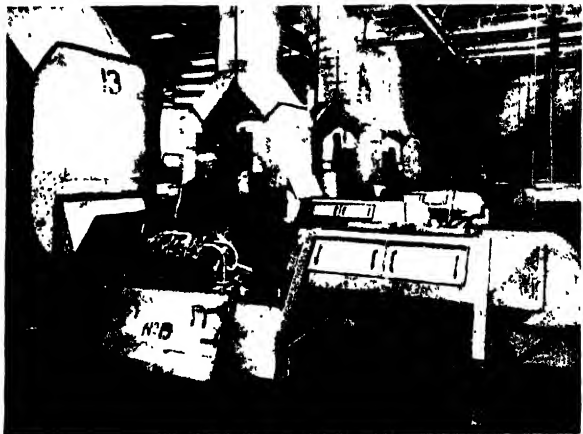
The separate humidifier (Figs 58 and 59), which is located in the rooms of many textile mills, is still solving the problems of a large number of such plants satisfactorily. However, air-conditioning systems such as those just described can be of benefit to such textile plants, particularly



Courtesy American Blower Co.

FIG. 62.—Cool Air Ducts for Men and Molds in the Glass Plant of Turner Bros., Terre Haute, Ind.

in the summer time, because, through them, humidity can either be added to or subtracted from the amount contained in the atmosphere at any given time. In summer time proper processing demands a subtraction from the amount of humidity in the air rather than an addition to that amount. See Figs. 60 and 61. Condensation in dye houses and other similar places can be eliminated with the air conditioning system just described, by directing outlet vents of dry warm air directly to the roof and to the floor. This prevents dripping at the top by absorbing the moisture, and similarly prevents the creation of a fog below. The problem of the bakery is solved by establishing a proof



Courtesy American Blower Co.

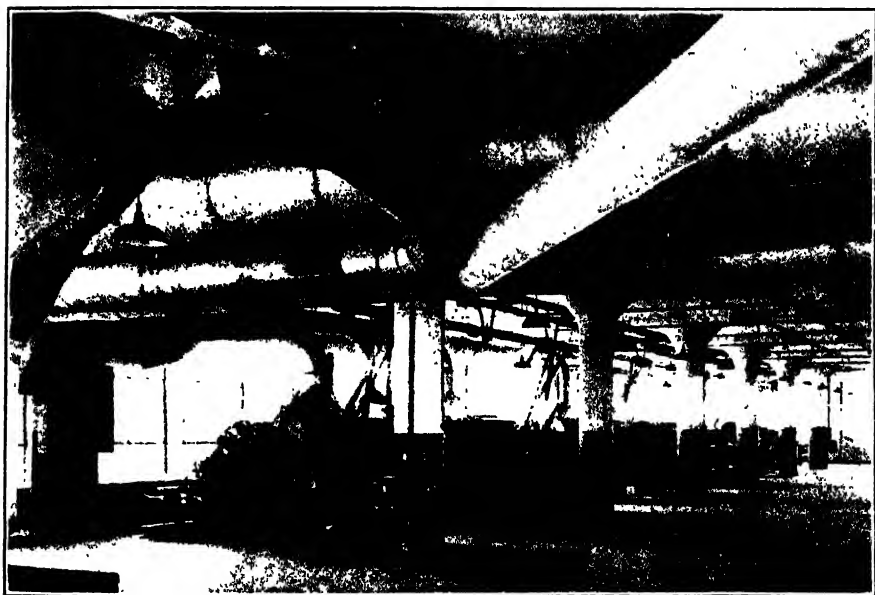
FIG. 63.—Exhaust System in Motor Testing Department, used for carrying off smoke, gases, etc., Willys-Overland Co., Toledo, Ohio.

chamber with a temperature of approximately 120 degrees and correct humidity, which is easily controlled. This chamber can be separated from the workrooms where the workers are found.

Glass factories and other plants where workers are likely to suffer from intense heat, can have the air conditions bettered by means of a ventilating system which includes cold-air ducts, such as those illustrated in Fig. 62 and installed at the Turner Brothers glass plant. Gases, or other waste products which would be likely to contaminate the atmosphere, can be eliminated by means of an exhaust system attached to the same air-conditioning apparatus that supplies air for the plant, in the way illustrated by Fig. 63, representing conditions in the motor-testing department of the Willys-Overland Company.

Removal of dust from materials worked in process may be made certain by a dust-collecting system, such as that illustrated in Fig. 64.

Note: For complete treatise on air conditioning see "Air Conditioning in Textile Mills," published by the Parks-Cramer Company, Fitchburg, Mass.



Courtesy The Carrier Company.

FIG. 64.—Dust Collection in Asbestos Carding.

CHAPTER XIV

FACTORY POWER

THE management of an industrial establishment is concerned with only two questions relative to factory power: (a) That there is adequate power at the machine to do the full amount of work scheduled for the factory. (b) That this power is secured in the most economical manner. The details of the methods determining the amount of power required, and of how it is to be obtained are problems to be solved by the engineer, rather than by the management. In fact, so technical is the solution of these problems, that it will be expensive economy to dispense with engineering advice on this subject. The subject of factory power is so large that it would be impossible to give it adequate technical treatment in this book, even though it properly had a place therein. It is only necessary to outline the general principles governing the subject so that the manager may consider intelligently the engineer's report.

Adequate power. The term "adequate power" will have different meanings in different industries, owing to the different character of demands on the power system. In a textile mill the power required per machine of each type is a relatively constant quantity, and adequate power here means sufficient power to run the maximum number of machines that may be in operation at one time. In a rolling mill, on the other hand, the power demands at each stand of rolls will vary from minute to minute, depending on whether the rolls are breaking down ingots or giving the final finishing pass to the rolled section. In machine shops, adequate power means power actually delivered at the cutting points of the tools in sufficient quantity to take all cuts at the highest possible speed consistent with the conditions of the work.

The delivery of adequate power to the cutting tools—or to the point of application of power in any machine—involves adequate strength in all the transmission machinery, including machine gearing, belts and shafting, and minimum losses in bearings, motors, gears, chains, belts, engines, generators, and boilers. Many companies are suffering from lack of adequate power, not because they have insufficient boiler or engine capacity, or motors apparently too small for the job, but from lack of attention to the connecting links between the primary source of supply and the point of application of the power.

Some of the causes of apparently inadequate power which have been encountered in industrial plants, and the remedies applied are:

CAUSE	REMEDY
Machine gearing too weak for work.	Heavier gearing.
Belts unable to pull load.	Heavier belts or greater tension in belts.
Excessive line-shaft friction losses.	Roller bearings on shaft. Alignment of shafting.
Machines requiring relatively constant power on same shaft with machines taking heavy drafts of power at irregular intervals.	{ Regrouping of machines. Individual motors on heavy power consuming machines.
Main motor too small.	{ Group driving.
Generator too small (Alternating Current).	{ Individual motors on heavy tools. Raising power-factor of load.
Engine capacity inadequate.	{ Resetting valves. Repairing of leaky valves and pistons. Installation of condenser.
Insufficient boiler capacity.	{ Boilers cleaned of soot and scale. Supervision of firing. Mechanical draft. Better operation of stokers. Redesign of furnaces. Change in fuel. Use of exhaust instead of live steam for heating.

Inadequate power does not always mean, in the case of the individual power plant, insufficient generating capacity; or in the case of purchased power, too small motors. The investigation of the sources of loss between boiler or motor and the point of application of power may postpone to a distant date the purchase of new boilers, engines, generators, and motors. Adequate power is an engineering problem from start to finish. The wisest management will be guided by the advice of engineers in its solution. A few hundred dollars spent for engineering services may easily result in the saving of several thousand dollars of operating cost annually.

Sources of power. Broadly speaking, the industrial plant has two sources of power supply. It may make it in its own power plant, or it may purchase it from a central station. The former is generally referred to as isolated plant power, and the latter as central station power. Whether to use one or the other is largely an economic question, modified to some extent by considerations peculiar to the plant itself. The basic principle to govern the selection is: That source of power is best which will deliver an adequate amount of power at the lowest cost per horse-power-year. Local conditions of the plant, and the best form of contract that can be made with the central station must be taken into consideration. Before this principle can be applied, an analysis of the items entering into

the cost of power must be made, and the influence of local conditions on these items considered.

Classes of power plants. Leaving out the plant which is driven directly from a steam engine or hydraulic turbine by belts or ropes, and considering only those in which the prime mover generates electric current which is utilized in motors, etc., we find that current can be generated by (a) steam plants, using either engines or steam turbines; (b) hydro-electric plants; (c) gas-engine plants, using producer, natural, blast-furnace, or coke-oven gas; (d) internal combustion engine (other than gas) plants employing fuel oil, gasoline, or other liquid fuel. A study of the steam plant will be sufficient to illustrate the principles involved.

Items entering into cost of power. The cost of power is made up principally of the following items: Fuel, water, attendance, labor, supplies (waste, oil, etc.), interest on investment, depreciation, maintenance, and repairs. The analysis of the cost of power into these items can best be illustrated by an example.

EXAMPLE. Assume an isolated plant with a maximum capacity of 1500 kw., generated by two 750-kw. turbo-generators, steam being supplied at 200 pounds per square inch pressure and 100 degrees superheat, by two 300-horsepower boilers, equipped with underfeed stokers. The plant is located adjacent to a river or other source of water, from which water can be pumped for boiler feeding and condensing. It is also equipped with coal- and ash-handling machinery, to reduce the labor in the boiler house. The power plant furnishes power to a manufacturing establishment that operates 60 hours per week, 306 days in the year. For the purpose of simplifying the analysis, it will be assumed that the factory continuously uses the entire 1500 kw. output of the power plant.

The records show that coal is bought for \$6.00 per ton, and is used as follows: For supplying steam for operation, 30,400 pounds per working day; for stand-by with banked fires, 14 hours per working day, 3500 pounds per day; for stand-by, 52 Sundays and 7 holidays per year, 177 tons per year. The total coal used is 5364 tons per year, which at \$6.00 per ton amounts to \$32,184.

The turbines require that 246,000 pounds of water be pumped into the boilers per working day. The condensers require, on an average throughout the year, 25 pounds of condensing water per pound of steam or 6,150,000 pounds per working day. The cost of this water is the cost of pumping. Approximately 20 horsepower or 15 kw. is required, and at a cost of electric current of 1.4 cents per kilowatt-hour, the cost of pumping for 3060 working hours per year will be \$643.

The operating force for the power plant comprises a chief engineer, an assistant engineer, two firemen, and two laborers. The power-house payroll amounts to \$13,000 per year.

The total investment in the power plant may be taken as \$100,000. For convenience, we may assume a uniform average depreciation rate of 5 per cent on the entire plant.¹ Taxes may be put down at \$2500 and insurance at \$250.

We may then tabulate the cost of the several items of making power as follows, using round numbers:

Coal.....	\$32,200	Average cost of current per kw.-hr. = $\frac{65,600}{3060 \times 1500} = \0.014
Water.....	650	
Attendance and labor ..	13,000	
Interest at 6% ..	6,000	
Depreciation at 5% ..	5,000	
Maintenance and repairs ..	5,000	
Supplies ..	1,000	
Taxes.....	2,500	
Insurance ..	250	
Total ..	\$65,600	

The foregoing represents a very efficient isolated electric plant, as it requires but a little over 2 pounds of coal per kw.-hour. This is a better record than many medium-sized central stations have. These figures include the bare cost of power alone, and take no account of steam requirements for heating in winter, or steam for processes requiring heat in the plant, of load factors or power factors, all of which modify the calculations and will be discussed later.

Central station power. The central station, manufacturing electrical energy in large quantities, owing to the refinements in apparatus which it uses, and which are not usually feasible for the small isolated plant, can deliver current at its switchboard at a much lower cost than many isolated plants. Even adding to the cost of current, as calculated in the preceding paragraph, the cost of distribution, it can usually deliver it at the terminals of the customer's meter in a moderate-sized plant at a lower cost than the customer can make it for himself. This also applies in many cases where the power user must install a separate steam plant for heat in winter, and for steam used in processes. Unless an isolated plant is of such size that it will pay to install apparatus that will approach in economy of operation that of the central station, or unless the steam required for process and heating is of such volume as to utilize all of the exhaust from the prime mover, central station power will generally be found to be the cheaper. As a rough rule, if central station power is available it will seldom pay to generate power on the premises in amounts

¹ The depreciation to be charged against the various items of the plant, as boilers, turbines, generators, buildings, coal-handling equipment, etc., vary widely, and in actual practice the items should be separated and the proper rate applied. For the purpose of illustrating the principles involved, however, a uniform rate may be used.

of less than 500 horsepower, unless there is a use for all of the exhaust steam.

Load-factor.—Before considering whether or not central station power is advisable in a particular case, it is well to have an understanding of the method by which rates are fixed for central station current. The load on a power station varies from hour to hour, and the maximum load is much in excess of the average load. Nevertheless, the station equipment must be of sufficient capacity, and enough boilers must be kept under steam, to enable it to respond, almost instantly, to any demand that may be made upon it. The cost of the surplus equipment, and of this readiness for service must obviously be carried by the customer, and is reflected in the rates he is charged for current. It is clear, therefore, that the closer the average demand can be brought to the maximum capacity of the station, the smaller will be the cost of carrying the surplus equipment, and the charges for current can be correspondingly lowered. The relation between the current actually produced and the maximum capacity of the station is known as the load-factor. The load-factor of a given industrial plant is the ratio of the average power used to the peak power used. The period over which the average power for the determination of the load-factor is to be taken is a calendar interval of not less than a week. The period for which peak power is taken is usually stated in the rates of the power company, but it is ordinarily half an hour.

Power-factor. Power-factor is a term applied to the ratio of the energy apparently developed by an electric generator to the power actually developed. With direct currents the power developed can be ascertained by multiplying the reading of the voltmeter by the reading of the ammeter on the switchboard, the product being the power in the circuit in watts. With alternating currents this product does not represent the power, except under certain conditions and with certain classes of load.

An induction motor will cause electrical conditions in the circuit which will render possible the utilization of only a fraction of the power apparently developed by the generator. On the other hand, certain other types of electrical machinery will set up other conditions, which, while also reducing the percentage of developed power that can be utilized, are opposite in their electrical effects to those of the induction motor. Such machines, if connected in the same circuit as the motor, will tend to neutralize its effect on the electrical system. Still other classes of loads, as lights and synchronous motors under certain conditions, have no effect on the apparent power in the system. Thus, if an alternating-current circuit supplied only lights, its power-factor would be unity. If it supplied only induction motors, its power-factor would be less than unity, and might be as low as 0.50. That is, the energy in the circuit available for doing work would be represented by (voltmeter

reading \times ammeter reading \times power-factor). The value of the power-factor could be raised by connecting in the same circuit lights or apparatus of higher power-factor, or apparatus of such character that it would tend to neutralize the electrical conditions set up by the induction motor. The power-factor will be the average power-factor of the several classes of equipment, due consideration being given to the size of the loads of each class. The design of the electrical system and the selection of equipment to give high power-factor is a problem for the electrical engineer.

Low power-factor is undesirable in many respects. In the first place, it increases the cost of power. The prime-mover driving the generator is required to develop power equivalent to volts \times ampere \div power-factor to deliver at the motors power represent by volts \times amperes. It is evident that a power-factor of 0.70 will require 14 per cent more capacity at the prime-mover than a power-factor of 0.80 on the same circuit. Furthermore, low power-factor will mean larger generators and poor regulation of the electrical system. So serious is low power-factor that central stations generally charge more for current supplied to plants whose power-factor is below a certain figure, usually 80 per cent.

The same disadvantages of low power-factor apply to isolated plants as to a central station, except that in the case of an isolated plant they may be more serious. Due to the distribution of the central station load among many customers, low power-factor in one plant may be balanced by high power-factor in another. The isolated plant, however, can overcome low power-factor only by judicious selection of equipment, and sometimes only by an expensive change in equipment. The power-factor may frequently turn the decision for or against the central station.

The cost of supplying consumers with power is made up of several other items in addition to the actual cost of the current itself. Theoretically, each customer should bear his proportion of the cost of the distribution system from the central station switchboard to his own meter terminals. Whether or not any current is used in a given month, the distribution system is there, and the charges on it must be met. Then, too, certain electrical losses occur in the distribution system and transformers, even though no current is used. These losses are a fair charge on the customer. In addition, there is the cost of keeping in service the surplus equipment to meet the peak-load power demands.

The method of charging these costs to the consumer varies with different companies and in different parts of the country. Some companies have a service charge to cover the cost of the distribution system which is a flat rate irrespective of the amount of current used, with an additional charge for the actual amount of electrical energy consumed. In addition, there may be a stand-by charge to cover the cost of surplus equipment kept available for the customer's use. This is on a sliding

scale and decreases as the quantity of current used increases. Then, finally, there is a charge for the actual amount of current used, which charge is on a sliding scale, decreasing as the use of current increases.

While the form of contract and schedule of rates vary with different companies, that of the Philadelphia Electric Company (Fig. 65) may be taken as typical. It is based on the maximum average demand for power over a given period of time, and on the agreement of the customer to use a certain minimum amount of current in a month.

This maximum demand is the measure of the equipment that the central station must install to be able to supply all the customer's needs. The minimum charge is based on an amount of current which will meet the cost of holding the surplus equipment in reserve, in addition to furnishing the actual current required. When this charge has been met, any additional current can be furnished at a lower cost, and therefore the rates may be lower for increments of energy above the minimum. Hence the sliding scale of charges for increased current consumption.

FIG. 65.

EXCERPTS FROM TARIFF OF RATES—PHILADELPHIA ELECTRIC CO.

The *Installed Load* consists of all the current-consuming devices located on the premises of the Customer which are connected to the Company's service, or which can be connected by the insertion of fuses or by the closing of a switch, the manufacturer's correct rating in kilowatts or kilovolt-amperes being used to determine the magnitude of the load. In the absence of such rating or whenever a test, made by the Company, shall indicate improper design or rating of a current-consuming device, a rating will be determined on the basis of the kilovolt-amperes required for the operation of the apparatus. At the option of the Company empty lamp sockets may be assessed upon the basis of fifty (50) watts for each such socket.

The *Measured Maximum Demand*, unless otherwise stipulated, is the greatest load used during the month or billing period as measured by an instrument giving the average of the demands over a thirty (30) minute time interval or by an instrument requiring approximately thirty (30) minutes to show full value, provided that in the case of hoists, elevators, welding machines, electric furnaces or other installations where the use of electricity is intermittent or subject to violent fluctuation, the Company will base the Customer's maximum demand upon approximately a five (5) minute instead of a thirty (30) minute interval and reserves the right to require the customer to provide at his own expense suitable equipment to reasonably limit such intermittence or fluctuation.

A *Horse Power* as used in this Tariff shall be computed as the equivalent of seven hundred and fifty (750) watts.

Power Factor as used in this Tariff is, in a single-phase circuit, the ratio of the watts to the volt-amperes, and in a polyphase circuit is the ratio of the total watts to the vector sum of the volt amperes in the several phases.

Rate "C" Retail Power Service.

7½¢ per kilowatt hour for electricity used equivalent to or less than the first 48 hours' use per month of the *assessed or measured maximum demand* in the month.

5½¢ for the next 48 hours.

2½¢ for all over 96 hours' use of the assessed or measured maximum demand in the month.

Maximum Demand.

The assessed maximum demand shall be equal to eighty-five (85) per cent of the first ten (10) kilowatts of installed load plus fifty-five (55) per cent of all additional kilowatts.

For billing purposes this installed load can in no case be less than the connected load, as specified in the contract, for which the Company is required to supply service.

Any Customer may have the maximum demand measured, for a period of not less than one (1) year, instead of assessed as provided above, by paying an additional charge of seventy-five (75) cents per month for twelve (12) consecutive months and thereafter as long as electricity is supplied under this provision.

The maximum demand may be measured, instead of assessed as provided above, at the option of the Company at its own expense.

The assessed or measured maximum demand may be corrected in accordance with the provisions of Clause No. 18 of the Standard Terms and Conditions, whenever the power factor of the Customer's load is found to be less than the standards therein specified.

18. Special Measurements.

The Company reserves the right to inspect any Customer's installed load, and also the right to place at its own expense maximum demand meters, reactive component meters or other instruments on the premises of any Customer for purposes of measuring the demand, power factor or for other tests.

The Company reserves the right to measure the power factor of the customer's load at the point where the electricity is metered, and if the power factor (which shall be the average power factor under normal operating conditions) is less than eighty per cent (80%) for an installation having an assessed or measured maximum demand of less than fifty (50) kilowatts or is less than ninety per cent (90%) for an installation having an assessed or measured maximum demand between fifty (50) kilowatts and one thousand (1,000) kilowatts, or is less than ninety-five per cent (95%) for an installation having an assessed or measured maximum demand exceeding one thousand (1,000) kilowatts, then such maximum demand shall be increased for billing purposes in accordance with the ratio between the applicable percentages as aforementioned and the measured power factor.

Minimum Charge.

Fifty (50) cents each month per horse power installed, subject to a monthly minimum charge of one dollar (\$1.00).

Rate "D" Wholesale Power Service.

Available for service for power and associated lighting requirements, provided that such lighting requirements are not in excess, either as to connected load or current consumption, of fifty (50) per cent of the Customer's total requirements.

Rate:

Stand-by Charge: \$2.50 per month per kilowatt for the first twenty-five (25) kilowatts of the maximum demand in the month; \$2.00 per month per kilowatt for the next seventy-five (75) kilowatts of the maximum demand in the month; \$1.75 per month per kilowatt for the excess of the maximum demand in the month over one hundred (100) kilowatts.

Current Charge: In addition to the Stand-by Charge for all current used for power purposes:

Four (4) cents per kilowatt hour for the first 1,000 kilowatt hours' consumption in the month;

Three (3) cents per kilowatt hour for the next 2,500 kilowatt hours' consumption in the month;

One (1) cent per kilowatt hour for the next 6,500 kilowatt hours' consumption in the month; Nine-tenths (.9) of a cent per kilowatt hour for the excess consumption over 10,000 kilowatt hours in the month.

For all current used for lighting purposes, wherever such current can be separately metered, one-half (½) cent per kilowatt hour additional to the charges mentioned above.

The Current Charges under this contract shall be increased one-twentieth of one mill per kilowatt hour for each five-cent increase per ton above an actual cost of coal to the Company of four dollars (\$4.00) per ton of 2,240 pounds at initial point of delivery. The determination of the actual cost of coal delivered shall be made for a period of three months and all Current Charges based upon such determination shall be applicable to all bills rendered covering current consumed during the next succeeding three months. The initial point of delivery above referred to is the yard of the Generating Station of the Company.

The current charges under this rate shall be decreased by one (1) mill per kilowatt hour.

Determination of Maximum Demand.

For installations of forty kilowatts or less the assessed maximum demand shall be the sum of the assessed power demand and the assessed lighting demand.

Assessed Power Demand: Eighty-five (85) per cent of the first ten (10) kilowatts of installed power load plus fifty-five (55) per cent of all additional kilowatts of installed power load.

Assessed Lighting Demand: Seventy (70) per cent of the installed lighting load in kilowatts.

For billing purposes this installed load can in no case be less than the connected load, as specified in the contract, for which the Company is required to supply service.

Any Customer may have the maximum demand measured, for a period of not less than one (1) year, instead of assessed as provided above, by paying an additional charge of seventy-five (75) cents per month for twelve (12) consecutive months and thereafter as long as electricity is applied under this provision.

The maximum demand may be measured, instead of assessed as provided above, at the option of the Company at its own expense.

For installations in excess of forty (40) kilowatts the maximum demand for the month and the power factor will be measured by an instrument or instruments installed by the Company.

The assessed or measured maximum demand may be corrected in accordance with the provisions of Clause No. 18 of the Standard Terms and Conditions, whenever the power factor of the Customer's load is found to be less than the standards therein specified.

The justice of such a method of charging will be seen from a simple example. If at certain times of day a customer requires 1000 kw. of

energy, and during the balance of the day only 600 kw., the central station must provide equipment sufficient to produce 1000 kw., even though it be used for only a short period. In addition, the wiring, transformers, switches, etc., must be proportioned for 1000 kw. If now, the load be increased to 1000 kw. for the entire day, the cost of the equipment will be distributed over a larger number of units of electricity, and the cost per unit can be correspondingly lower. Hence, a plant with a high load-factor is entitled to and does receive a lower rate than one with a low load-factor. Likewise, a high power-factor will decrease the cost of generating electricity, and plants with low power-factors are penalized by higher rates.

Central station vs. isolated plant. We are now in position to make a comparison of the relative cost of power as bought from the central station or made in the factory power plant. We have in a preceding paragraph ascertained the cost of making power in an isolated plant under certain given conditions. Assume that this same plant were to buy central station power under rate-schedule D in Fig. 65.

The cost for one year would be calculated as follows:

Stand-by charge per month

50 kw. @ \$2 50 =	\$ 125 00
75 kw. @ \$2 00 =	150 00
1375 kw. @ \$1 75 =	2406 25
	<hr/>
	\$2681 25

Current charge per maximum month of
26 working days @ 15,000 kw.-hr. per day

1000 kw. @ \$0 04 =	40 00
2500 kw. @ 0 03 =	75 00
6500 kw. @ 0 01 =	65 00
380,000 kw. @ 0 009 =	3420 00
	<hr/>
	\$3600 00

Total cost per month \$2681 25 = \$75,375 per year.

The comparatively low cost of the isolated plant power, \$65,600, is due partly to the high load-factor and partly to the assumption of extremely high operating efficiency. In addition to power, most factories in the United States require heating for from four to six months per year, and this heat must be provided by either exhaust or live steam. With central station power a separate heating plant would be required.

Let us assume the plant in question to be of such a size that a survey by a heating and ventilating engineer showed that 16,200 pounds of steam would be required per hour to maintain a temperature of 60 degrees in zero weather, and that the heating plant would have to be operated at full capacity for two hours before starting time in the morning to

pick up and carry all the load, except at the peaks. This would hardly affect the industrial plant, as industrial loads mainly come in between the peak loads.

In the isolated plant the reserve for breakdown consists in either having spare units in reserve, or in so selecting units that any one can be shut down, and the remaining units, by taking a temporary overload, will be able to provide the necessary power. For instance, instead of having the load divided between two units, it is advisable to have it divided among three, each operating normally at its point of best efficiency, any two of which would be able to carry the load at a somewhat lower efficiency. With either of these arrangements the isolated plant should be as reliable as the central station.

Fuel storage and service. The reserve supply of fuel is an important consideration in all power calculations. A plant so located that it is accessible to its source of fuel, as on a railroad line connecting directly with the coal mines, or on a water-course providing all-year transportation from the mines, need carry only a small reserve. If, however, it must depend on trucking its fuel, or is in a district inaccessible to the mines, or on railroads which may be interrupted in winter, the fuel reserve must be large. For instance, plants in the Northwest, far removed from the mines, and where snow blockades the railroads for long periods, may have to carry a reserve sufficiently large to supply them throughout the winter. The interest on the investment in the fuel so carried is a proper charge on the cost of power, as is also the interest on the value of the real estate used for storage, together with the taxes, etc., on it.

Central stations usually carry adequate reserves of fuel, and are so located as to receive and handle these reserves in the most economical manner. The cost of the fuel reserve is, of course, included in the rates charged for power. In choosing between isolated plant or central station power, the question of fuel supply and reserve must not be neglected.

Use of steam for heating and process. Where much heat at steam temperature is required in the processes of the plant, or where the quantity of steam for heating in winter is large, it is usually wise to use exhaust steam for this purpose. If all of the exhaust can be so used, the power is a by-product, that is, it is obtained at no cost, except the interest on the investment in power-generating apparatus, the maintenance, repairs, etc., on it, and the attendance. In such a case, the efficiency of the power-generating apparatus need not be so high as where it is used solely for power purposes, although as a general rule, high-efficiency machines are in all ways more satisfactory than low-efficiency ones. The boiler and fuel-burning appliances are excluded from the low-efficiency classification, for they should be operated at the highest possible efficiency, irrespective of the use to which the steam is put.

The method of determining whether it will be better to use central station or isolated plant power in cases where large amounts of steam are used for heating, is the same as outlined in the preceding paragraphs for the factory heating system in connection with central station power. That is, the amount of steam required is determined and the cost of making this steam is ascertained. If it costs less to make it and buy central station power than to generate power on the premises and use exhaust steam, central station power would be the logical choice.

The problem, however, is not as simple as this. Instead of using exhaust steam, the isolated plant might find it more economical to operate its power units in connection with a condenser, and use live steam for heating. Or in a high-efficiency steam turbine plant it might bleed a portion of its steam for heating from the turbines, still operating these condensing, and make up the heating deficiency with live steam. The problem is often a complicated one.

Combination of central station and isolated plant power. Instead of generating all of its own power or of buying all of it from a central station, the industrial plant may find it of advantage to generate a portion and purchase the balance. In this case it may either buy sufficient power from the central station to meet its average requirements, generating in its own power plant the power for the peaks of the load, or it may reverse the conditions and buy from the central station the power for peak loads and for breakdown service. The former combination will reduce the unit cost of power from the central station, as the average load will then approach more closely the maximum load, enabling the plant to take advantage of the lower rates obtaining with high load-factor. The latter procedure will increase the unit cost of power bought from the central station due to the low load-factor, but the total cost of power may be less.

No definite rule can be laid down as to the best method of obtaining power in any particular plant. Whether to buy all or part of the power required from the central station must be determined on the merits of each case, all the factors being taken into consideration.

Distribution of power within the plant. The source of power having been determined, there remains to be decided the method by which the power shall be distributed in the shop. In general, three methods are in use: *a*, single-motor main drive; *b*, group drive; *c*, individual-motor drive. The three systems are illustrated in Figs. 66, 67 and 68.

Single-motor main drive. The single-motor main drive has little to commend it except low first cost. It is largely a survival of the days when the entire factory was driven from the flywheel of a steam engine, before the electric motor permitted power to be distributed in any direction and in any quantity desired to any part of the plant. In effect, this

drive consists of a motor large enough to carry the maximum load that may occur at any one time, belted to a main line-shaft. This line-shaft drives, through belts or other connections, jack-shafts which in turn drive the machine countershafts. The disadvantages of this system are so many and so great that it should not be considered except under exceptional circumstances.

Group drive. In the group drive, instead of the jack-shafts being driven from a main line-shaft, each is driven by its own motor. Or the line-shaft may be cut into sections, each driving a group of machines, each section being driven by its own motor. Or, the various machines of each class may be arranged in groups, and the shafting for each group

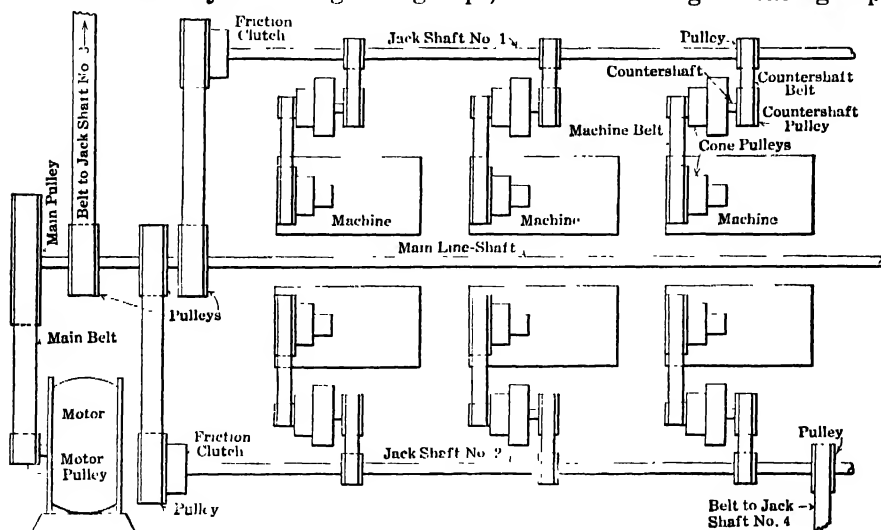


FIG. 66.—Single-motor Main Drive.

driven by a single motor. This system, while of greater first cost than the single-motor main drive, is so much more flexible and has so many inherent advantages, that it is the most generally used. With it the shafting friction losses are lower than with the single-motor drive, and any section of the shop can be run at any time without having to drive all the shafting. The machines can be arranged more conveniently for the work, without regard to the position of main line-shafts, and without quarter-turn belts or mule-pulley stands to permit power to be taken off the main line-shaft at right angles to it. The motors can be better proportioned to the average load they will be called on to carry, and the load-factor, and hence the efficiency, of the system will be high.

Individual motor drive. In the individual motor drive, each machine has its own motor, either mounted on it and driving through gears or

silent chain, or mounted close by and driving through a belt. This is the most flexible of all systems, and permits machines to be arranged in the manner and position most suitable for the work without any regard for the source of power. It is highest in first cost, and the total horsepower of motors to be installed is greater than in either of the other systems, since each machine must be equipped with a motor large enough to pull the heaviest load that may come on the machine. This will tend to make the load-factor low and also the power-factor if alternating current is used. In the group drive, the motor usually need be only large enough for the average load, since it is quite unusual for every machine in a group to be under maximum load at the same time.

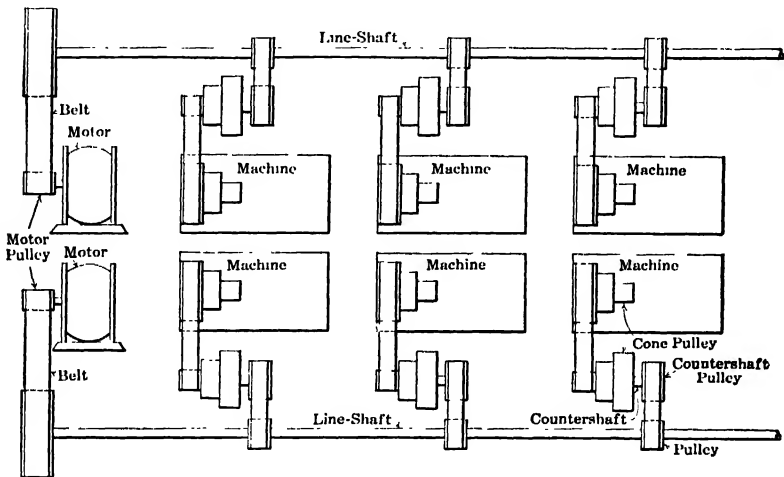


FIG. 67.—Group Drive.

Combination group and individual motor drive. Probably the most satisfactory system of driving, particularly in the metal-working industry and in those industries where the demands for power on the several machines is variable, is a combination of the group and individual motor drives. In this system the machines requiring a relatively constant amount of power are driven in groups, while those requiring a large amount of power at irregular intervals are equipped with individual motors. This gives a very flexible system and smooth operation. It is highly undesirable to connect to the same shaft machines using a comparatively small quantity of power, such as screw machines and turret lathes, and machines taking large drafts of power at irregular intervals, such as punch presses and heavy planers. The combination system solves this problem in a very satisfactory manner. The load-factor will be comparatively high and the power-factor with alternating current moderately so.

Maintenance. Of more importance, perhaps, than wise initial selection of equipment for power generation and distribution, is the establishment of a routine that will insure all of the power-generating, power-transmitting, and power-using equipment being kept up to its original condition and efficiency. Boilers become scaled and dirty, and their settings develop air-leaks, all of which increase the coal consumption. Engine valves require adjustment from time to time and bearings need taking up. Air-leaks may develop around turbine glands and bearings may become worn to such an extent that the turbine will be damaged. Motors may become dirty, and commutators and brushes wear out. Line-shafts, jack-shafts, and countershafts must be kept in alignment,

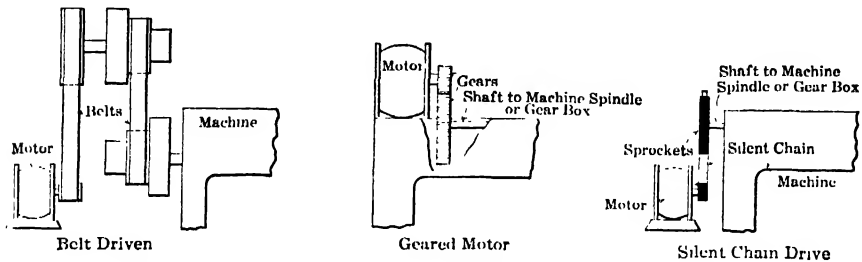


FIG. 68.- Typical Arrangements of Individual Motor Drive.

and constantly lubricated, and bearings must be looked after from time to time. Belts stretch and become loose, and must be inspected and kept up to the proper tension. Gearing will wear, and requires lubrication. Neglect of any or all of these things will cause the power bill to run up. Constant vigilance, and a regular system that will fix the intervals at which each item of equipment is examined and adjusted are an absolute necessity in any factory that intends to keep its power equipment at the point of highest efficiency.

Such a routine will pay for itself many times over. It will avoid breakdowns, for it will detect the causes of breakdown before they become dangerous, and will remedy conditions before they cause a smash. Preventive repairs are always less expensive than breakdown repairs, because they can be made at nights and noon hours without shutting down productive machinery in working hours.

CHAPTER XV

INDUSTRIAL SAFETY

The need for safety in industry. Twenty to twenty-five thousand workers in industry within the United States are killed annually while in the course of their employment. Two million suffer non-fatal accidents of varying degree which make them miss days of employment. What does this mean in terms of production delays, of injured organization morale, of increased costs and narrowed markets? The workman's compensation cost alone, which is added to selling price, must approach \$250,000,000 annually. Is it to be wondered at that employer and employee unite in the demand that all in industry become active allies in the accident-reduction army? It is the one phase of industrial management of which no one can question the desirability.

The organized accident-prevention movement. While the organized safety movement is comparatively new in industry, having reached sizable proportions only since the War, it can point to demonstrated achievements of great magnitude. Its rapid growth has been partly due to its humanitarian aspects, partly to the demonstrable fact that accident prevention pays, and partly to an effective national organization, The National Safety Council.

The effective direction of this organization has caused it to grow in membership and influence within a few years as have few national bodies of similar character. Effective national organization must rest partially on effective local organization. Interest aroused locally makes possible a yearly national gathering attracting several thousand persons from all parts of the nation. The organization of local safety councils is the effective method of arousing local interest.

Mr. William H. Cameron, Managing Director of the National Safety Council, who is in the best possible position to view safety nationally has said:¹

“Our workers, our citizens, must first understand what safety is; it must become a desirable and sought-for attribute of living. It must be worked into the habits of consciousness of children as they are taught to talk and live.

¹ Annals of the American Academy of Political and Social Science, January, 1926, p. 30.

"This is the conception of safety that has led the far-seeing business executive to adapt its principles as a part of shop-operation economy. He sees that safety is allied with efficiency; that every accident, or near-accident, causes an interruption to the work and, therefore, limits production. In many instances the study of safe operation has revealed methods for increasing the production. Safety, therefore, as a shop policy has an affirmative meaning to the alert manager—he sees safety as a conservator of men and materials. The method of safety is now coming to be looked upon as man's adaptation or protective reaction to new hazards, such as the increasing variety of power-machinery, and instead of permitting the processes of nature, through the instincts of self-preservation, to develop habits to meet the new conditions, the application of the science of safety is a definite attempt to hasten or facilitate the evolutionary process by focusing attention on each new accident hazard as it develops."

Casualty insurance companies carrying compensation insurance, through schedule rating of individual risks and through inspection service, have proved of inestimable assistance in accident reduction. Their effort has shown the great need for more definite analysis of accident causes as a basis on which the organized accident-reduction movement may rest.

The National Safety Code Program, sponsored by the best engineering minds in the country and reaching into all states and all industries, proposes standardization of codes and regulations. This ultimately must be of enormous cost benefit to builders and users of machinery at the same time that it insures uniform attention to all like hazards, promotes workable codes for jurisdictions which cannot afford to prepare their own and consolidates the experience of the larger industrial states which have dealt with these engineering problems in many thousands of establishments.

The development of these national codes is under the direction of the American Engineering Standards Committee, with all interested groups cooperating. The National Safety Council, The Bureau of Casualty and Surety Underwriters, or the American Society of Mechanical Engineers may direct the development of a national safety code. The Federal Department of Labor and state labor departments add their experience and effort to the development of these codes.

The development and enforcement of safety laws and codes in the several states has been a gradual process and has met with varying success in the several jurisdictions. Because of the rapid development of the national safety movement, these agencies are giving advice of a technical nature more frequently than they are enforcing rules, in establishments of any size.

Does accident prevention pay? Mr. G. A. Orth, Manager of the Safety Department of the American Car and Foundry Company, has said:²

² *Annals*, January, 1926, p. 22.

"Hitherto, the two chief factors considered in a producing organization have been material (including machinery) and personnel (including organization). To these I would now add a third factor, namely, accident prevention. Accident prevention directly affects both the material and the personnel; and it affects them in four directions:

- (1) *Increased Production*
- (2) *Decreased Overhead*
- (3) *Decreased Labor Turnover*
- (4) *Saving in Money Compensation*

"(1) Production is increased by accident prevention by conserving the energy of the workers, both in physical fitness and in time, for the purpose for which that energy is employed. It prevents the dissipation of any portion of that energy through accidental physical disability, loss of time, loss of power in replacement. It keeps constant the stream of force which has been canaled for the purpose of turning the wheels of the producing mill. Anything which stops the flow or diverts the current of that stream, lessens productive power. Anything which keeps it in its steady course, increases productive power. It follows, as a corollary, that a system, either of appliances or organization or of both, which would eliminate accidents, must be a paying system.

"(2) Overhead is decreased by accident prevention in substantially lessening both the cost of insurance and the cost of compensation. But there is a further decrease. The cost of accidents is far more than the cost of compensation to the injured worker. The loss in time due to the disorganization which follows an accident, the delay in 'speeding up' the plant afresh, represent losses not easily calculable in figures, yet they usually end in loss of often many hundreds of hours for which there can be no return. These working hours are utterly wasted, so far as production is concerned. Accident prevention avoids such a loss, and this is a definite gain in overhead decrease. It, therefore, pays.

"(3) Labor turnover is a non-productive expense. Accident prevention decreases that expense. The absence of workers due to accidents compels a change in personnel. A change in personnel means loss of time and loss in efficiency. Loss of time and loss in efficiency are non-productive expenses. Accident prevention eliminates these expenses. It, therefore, pays. All accidents disrupt the morale of any organization of human beings, especially one of a hazardous nature. Accident prevention keeps the working army in the even tenor of its way, preserves its morale, and saves the cost of recruiting and re-drilling. It, therefore, pays.

"(4) Money compensation is, of course, saved by accident prevention. That is obvious. The employing organization may insure itself against such a loss, but the cost of insurance is, *per se*, a non-productive expense. It

should, therefore, be lessened and avoided as far as possible. Accident prevention does lessen this expense, and lessens it very substantially. Accident prevention is in itself a form of insurance. It may be costly, but the cost is far less than the cost of the premiums charged by insurance companies. The American Car and Foundry Company spent \$1,000,000 for accident prevention in fourteen years. It saved approximately \$2,700,000 by doing this. The U. S. Steel Corporation expended \$9,763,063 in ten years for accident prevention. It has been calculated that it thereby gained \$14,609,920. It, therefore, pays."

The physical side of accident prevention. Industrial safety is discussed under "The Plant and Working Conditions," because it is the physical side of safety that must be considered first. Without having physical dangers guarded adequately, no plant can expect to win the workers' co-operation in educational programs for accident reduction. The necessity of adequate illumination as a safety factor was discussed in Chapter XII. Other phases of physical dangers include power-transmission equipment, points of operation on machinery, slippery floor and stairway surfaces, and danger to the eyes from flying particles.

Professor Victor S. Karabasz of the University of Pennsylvania points out the following facts:³

"On the whole mechanical power-transmission equipment is about the best guarded type of equipment. The problem of safety is (1) to see that the present standards are enforced so that as much of the hazard as can be removed by guarding will be removed, and (2) as important as guarding is the development of a code of safe practices for the use of the worker who may have anything at all to do with such equipment, and study shows that everyone from superintendent to laborer may fall into this class. There are two aspects of this subject: (1) that which has to do with the use of the right kind of equipment properly applied; and (2) that which has to do with sheer ignorance and carelessness on the part of the workers.

"Many accidents could be avoided if there was a more widespread knowledge of a few practical points in connection with belt economy, and not only would accidents be reduced but there would also result a real saving in dollars and cents to the users of belting. Belts poorly chosen for the power required on given operations, continually running off pulleys, slipping, stretching, poorly joined with an ill-adapted type of lacing, continued overuse of belt dressing wrongly applied, have been the causes of untold numbers of accidents, and probably will continue to be so in the future unless there is more general knowledge concerning these matters. The same thing holds true although to a lesser degree with the other types of transmission equipment.

"The carelessness and ignorance of workers and the false sense of

³ *Ibid.*, p. 151.

security while repairing, oiling, cleaning, and testing mechanical power-transmission equipment while in motion, in working amid rapidly revolving overhead shafts with loose clothing, in taking chances in order to save a few moments when chances are unnecessary, and in almost innumerable other ways, have resulted in sending many to untimely deaths, and others to hospitals with serious injuries. Workers do not realize the great dangers to which they expose themselves by these practices."

Figure 69 shows good standard practice in guarding power-transmission equipment. It shows exhaust hoods for taking particles of dust from the operation away from the worker and workplace. It also shows the use of goggles as a safety device in trades where there are flying particles from the point of operation.

Point-of-operation guarding is coming to be of great importance, because, while power-transmission machinery has come to be guarded well, little has been done with points of operation, except the first of the following three classes: (1) accidents from flying particles—emery and other abrasive wheels; (2) accidents due to contact with the moving parts of machines, as on punch presses; (3) accidents due to kick-backs of work, or parts of the machinery which move flying through the air. Examples of the third class are lumber kicking back from a circular saw and shuttles flying from the loom. Figure 70 illustrates an effective point-of-operation punch-press guard. Other types of guards sweep the worker's hands away from the descending tool and require him to have his hands on two separate levers before the press will trip. Figure 71 illustrates a shuttle guard that effectively keeps the shuttle from flying as it passes across the loom. This saves smashes of the warp as well as injury to the operator.

Accident prevention by making floors and walkways safe is a big factor



FIG. 69.—Power Transmission Guards, Exhaust Hoods, and Goggles Make this a Safe Work-place.

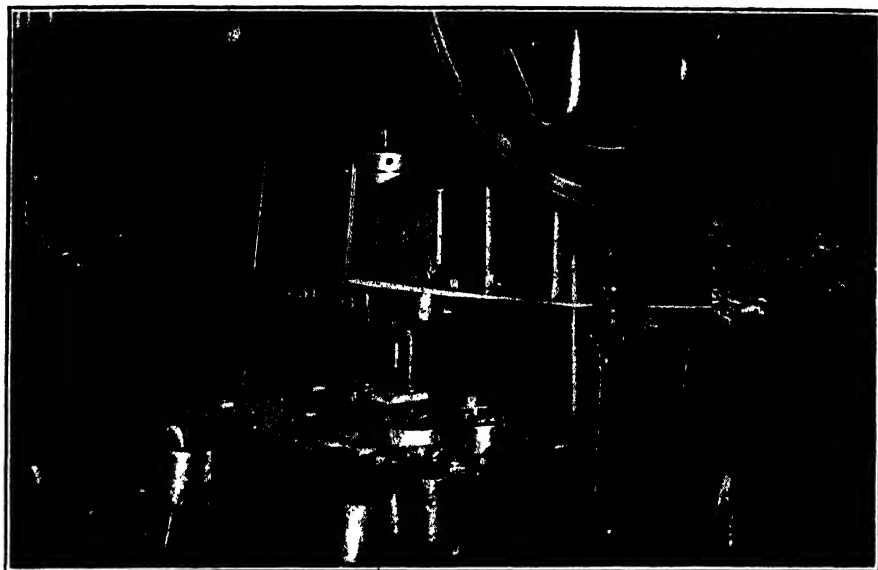


FIG. 70.—A Point-of-operation Punch-press Guard. (The guard has been removed from the fly-wheel so that the point of operation guard may be seen).

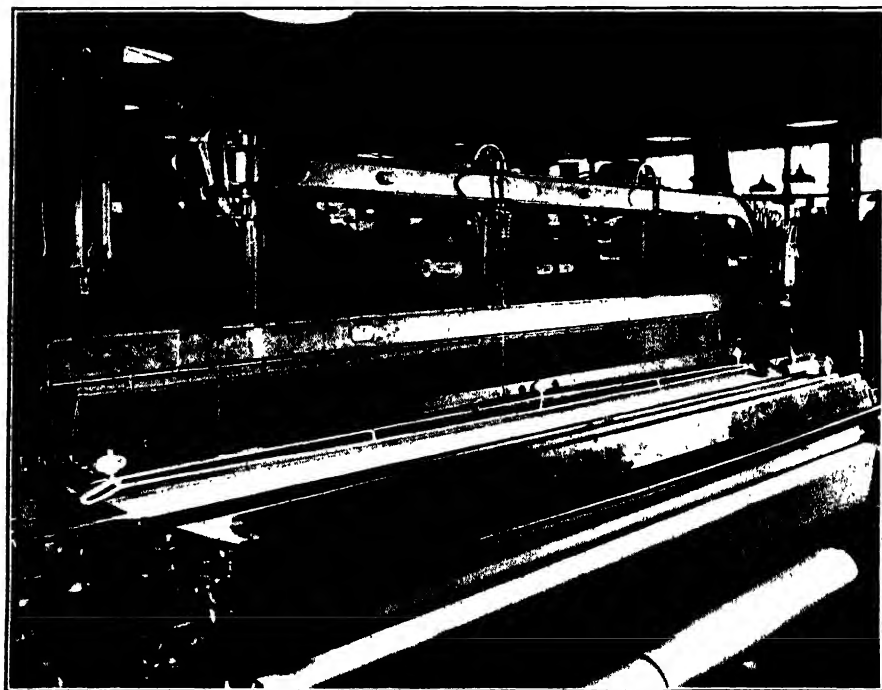


FIG. 71.—Loom Equipped with Shuttle-guard.

in the industrial accident toll. A study by the National Electric Light Association indicated that over one-third of all falls occur on the level and on stairways, and not from poles, scaffolds, or other equipment.

Adequate eye protection will save a large percentage of the eyes lost in industry each year. There is great need for having goggles handled by some one familiar with their use. This person should appreciate what constitutes a fitted goggle so that the wearer may, in addition to obtaining protection from the eye hazard he is compelled to encounter, be given the assurance of a feeling of security behind the devices.

Mr. Walter G. King, of the American Optical Co., and Past President of the National Safety Council, has said:⁴

"A cheap spectacle lens in the light frame will not offset the impact of a flying piece of steel, stone, or concrete, nor will an injurious ray be absorbed through the composition of a common sun glass of a varied hue. These are elements in themselves that unless considered will invariably break down the most conscientious efforts in plans to reduce eye injuries.

"Goggles may be handled as a tool or any other device in the plant and placed on a control or check basis. It is therefore advisable to give them the same consideration from the phase of upkeep and repair that a tool would receive. For is not their mission of a higher nature in most instances than the most expensive tool, when consideration of their use is measured as an economic factor of operation, combined invariably with their control from a social and monetary loss entailed through their lack or misuse? Therefore, a goggle should be thoroughly sterilized and reconditioned before being put in service again. One of the most destructive factors in the failure of effective eye-protection methods is the use of the general goggle, hung on a nail in a remote section of the shop and used by anyone for all purposes. This practice is a virulent source of not only an eye accident but disease and is comparable only to the common drinking cup and roller towel, long since relegated to the scrap heap of unsanitary practices."

Educating the worker in safety. Physical conditions having been attended to, the education of the workers in safety will maintain them, and will result in every worker being a safety man all the time that he is at work.

Departmental or group safety committees should be organized and the competitive spirit between departments aroused. An active safety committee will work strenuously to have a better record than its neighbor, and, once aroused, the men learn how to put the doctrine across. Vigorous and pointed safety bulletins should be liberally posted and frequently changed. Plant cartoonists will find here an admirable field in which to work and the fact that cartoons and bulletins are home-made and cite home events will increase their punch.

⁴ *Ibid.*, p. 163.

The plant magazine forms an excellent means of putting safety across to the workers. Nearly all plants which have safety programs of any size utilize safety posters of some kind. The National Safety Council has an elaborate poster service, and most of the casualty insurance companies include a poster service as one of the items in their workmen's compensation policies. Two safety posters of the National Safety Council are shown. Figure 72 is typical of the poster that arouses the interest of the worker in safety. Posters such as this, which include the meaning of safety to the folks at home, have been very successful in results secured. The other poster, Fig. 73, is applicable only to departments which have



FIG. 72.—A Safety Poster of General Appeal.



FIG. 73.—A Safety Poster of Appeal Within a Particular Department.

punch presses. Similar posters may be had which relate to specific hazards in almost every dangerous operation.

Mr. John Oartel, Chief of the Safety Bureau of the Carnegie Steel Company, who has had as much experience in the development of safety organizations as any one in the United States, says:⁵

"The organization that functions properly is one that is well fed, whether it be a man, an animal, a plant or a safety committee. Much of the indifference and lukewarmness on the part of the safety committees and the meagre results obtained by them have been due to the fact that

⁵ *Ibid.*, p. 201.

they have subsisted on a starvation diet. It is not sufficient to appoint safety committees and leave them to their own resources.

"Newspaper and magazine clippings, and articles referring to some phase of safety, prints, photos or circulars of new safety devices, reports of accidents, near accidents, or dangerous practices should be fed to the safety committees continually."



FIG. 74.—A Safety Meeting in the Shop During Working Hours. Duquesne Works, Carnegie Steel Co.

Figure 74 illustrates a safety meeting in the machine shop of one of the plants under Mr. Oartel's direction.

One of the direct results of safety education is to reduce the number of infection cases from accidents by having the injured worker report promptly to the dispensary for treatment. A sympathetic doctor and nurse will work wonders in persuading men to come to the hospital for first-aid, and first-aid prevents infection. Persuasion, as well as regulations, should be used in this direction.

PART IV

STANDARDIZATION (A PRIMARY MANAGEMENT STEP.)

CHAPTER XVI

STANDARDIZATION OF PRODUCT (SIMPLIFICATION)

FROM a purely production standpoint, every organization should prefer to produce only one of each type of product in its line. Such a program, although Utopian from the standpoint of the factory manager, is impossible in all but a favored few plants. Demands of the trade and of individual customers make imperative the diversification of product that is necessary to meet various consumers' needs, desires, and purchasing capacities. In some industries, such as those in which taste and style are important factors in purchase, an attempt to produce but one product of each type would mean industrial suicide. However, through many years of practice in meeting the desires and needs of the customer, many organizations seem to have forgotten that there is manufacturing preference for fewer products. They have proceeded so unnecessarily far in diversifying their lines that it has taken a distinct movement towards simplification, carefully fostered, to bring into prominence the economic and profit-making reasons for standardization, or elimination of excessive diversity of product. The benefits derived from elimination of excess variety are great. To understand them it is necessary to know the causes of development of excess variety, as well as the results, and the ways in which these may be counteracted to the benefit, rather than the detriment of the business.

Causes of unnecessary diversity of product. Unnecessary diversity of product has resulted from two main causes. The first of these is the demand of the consumer for product that is individually different, either to meet peculiar service needs, or because of the style and taste factors. The second, and wholly remediable cause, is that sales methods have frequently been based largely on supplying diversity. Although it will be seen shortly that much can be done toward the education of the customer in convincing him that his service needs fall under certain well-defined headings which may be supplied by standard products, and although taste and style demands for diversity may be modified, the most

fruitful immediate attack can usually be made by revising sales methods so that they will eliminate, rather than cause, diversity.

Sales divisions, selling agents, and salesmen themselves all have felt that one of their strongest selling arguments was that a particular product was a "novelty," or that it was different from anything they or their competitors had before presented to the trade. In addition, they have frequently urged the retailers to stock a huge variety of the product they sell, on the basis of appealing to the consumer's individuality complex. This has been frequently unnecessary and costly to the retailer, as it has meant to him carrying charges and damaged-stock charges which have been many times what they should have been. This may be illustrated from an industry manufacturing a universally used product. Stationers, druggists, and other retailers of writing paper have for years been sold a great diversity of stationery so that they might be better able to sell their customers on that basis. Although a share of the consumer demand is based on taste and individuality, nevertheless a large share of consumers, particularly men, are desirous of being able to obtain continuously the particular style of paper which they last purchased and which they used with satisfaction. To these consumers diversity has frequently meant annoyance, particularly in some such instance as having envelopes remaining which they have been unable to match in a new purchase of paper. Thus the diverse line, sold to the retailer on the basis of greater profit to him, has often meant lost sales, slower turnover of stock, and loss through injury to these fragile goods while lying on his shelves.

There is a class of sales in this same industry which is based wholly on individuality and diversity. Some high-grade stationers have built up their business on the basis of selling their consumer stationery which is different and which is "special" in every particular. Although some immediate loss of orders would doubtless ensue from an immediate change of policy on the part of these retailers, the manufacturing problems involved, and the costs to the retailer himself, are so great that such a selling policy must necessarily undergo a change. Special orders as small as twenty-four sheets of paper, with envelopes to match, are frequent, and one paper company has received as many as 5000 such orders in a single day during the holiday season. When it is known that most of these orders are ordinarily of the "rush" character, it can readily be seen that any steps toward their elimination would be profitable to everyone with the possible exception of the consumer, to whom, in this case, price is not usually an important factor.

By far the greatest cause of diversity of product has been the practice of selling on the basis of diversity in order to meet competition with a product that could not be easily compared, or with one on which quality or price could be readily shaded. This is the greatest factor in increasing

the lines of product manufactured. The development of this policy in the writing-paper industry can be illustrated from the statements¹ made by Mr. George A. Galliver, formerly president of the American Writing Paper Company, when simplification was first securing a foothold in this trade. He said:

"A jobber learned that a competitor had sold a printer a lot of paper of a certain grade. He then went after this business. He had three arguments to bring to bear in favor of his paper—improvement in quality, less price, or greater suitability. If he made what he looked upon as a big sale, he wanted it to be permanent and bring its own reorders. If he could lead the customer to believe that his paper would be inimitable and unique he might be protected from competition for at least a short time. The best way to stamp it as unique would be to have it made with a special brand in the watermark. Perhaps this brand that he was selling was at the time of the sale purely an imaginary one created in his own mind to induce the sale. Having tentatively made the sale, the jobber would then see the factory salesman and dicker with him for the manufacture of a grade of paper very similar to the other jobber's brand which he was to beat out, and with the price shaded a cent or two—enough so that he could undersell his jobbing competitor without losing money, and still not too much but what he could convince his prospect that the new brand was just as good. Naturally the factory salesman was also eager for business, and he accepted the order with the shading of price. Then he went back to the factory and compelled the mill men to make the paper, arguing that they could meet the almost insignificant falling off in price by making an equally insignificant reduction in the proportion of the best ingredients in the paper. This process once done would not be worth speaking of, but repeated every week and every day, it became a great vice."

Results of diversity of product on production. The effect of selling policies such as just described on the operation of the factory is such that the production costs mount rapidly and it is impossible to institute economies in operation which are simple with less diversified lines. The American Writing Paper Company, studying the losses involved in that type of selling methods, reduced their line from 2000 separate varieties of paper to approximately 200. Some of the production reasons for this change well illustrate the importance, from a manufacturing standpoint, of the standardization of product. The key machine in the paper-making industry, the paper-making or Fourdrinier machine, a huge machine from 50 to 200 feet long (Fig. 75), must be stopped and started every time a new grade of paper is run through it. Not only must many time-consuming adjustments be made on the machine, but there is a huge loss of material

¹ System, September, 1921. (A. W. Shaw Co.)

from wastage of paper as the machine is being finally adjusted. Frequently the down-time cost on the machine plus this wastage will be sufficient to cause an addition to the cost of production of from 10 to 15 per cent alone, when the runs of paper are short. In addition to these losses there will be the losses incident to idleness of equipment which performs subsequent operations on the paper, and operations which vary on the type of paper being manufactured. Such equipment includes paper-cutting machines, supercalendering machines, etc. The operations performed by these machines do not have to be done on all types of product, but with a highly diversified line it is impossible to plan ahead accurately enough to permit close computing of the exact number of machines of each type necessary to permit the proper balancing of operations. It is necessary to provide enough equipment to take care of unusual demands, and this means much idle equipment a large share of the time. This idle equipment cost is another factor in the increased cost of production with diversified product.

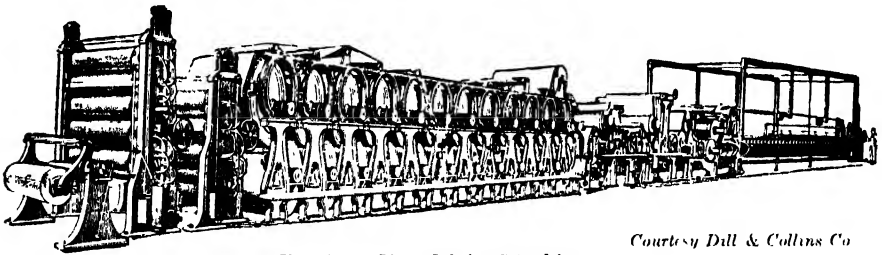


Fig. 75.—Fourdrinier Machine.

Courtesy Dill & Collins Co

Benefits of simplification. The benefits resulting from simplification are many more than those represented by direct lessening of production cost. In addition to this there may be mentioned these: decrease in capital invested, lower labor cost, advance in the technique of production, improvement in equipment utilization and control, and possibility of speedy and reliable delivery. Together these insure consumer satisfaction because of prompt service at low prices, together with greater profits on the same investment for the manufacturer.

A decrease in the capital investment is brought about through the utilization of less machinery and fewer tools, patterns, and other auxiliaries, as well as through the reduction in the inventories of raw material, parts, or partly worked material and finished stock. Lower labor costs come with familiarity of the workers with their more frequently repeated tasks, as well as from the steadiness of employment that follows the well-defined production programs that can be mapped out when the product is standardized. Unsteady employment usually means not only a poorer grade of workers, but even higher wage rates than when the employee feels the

certainty of steady work. Stabilization of employment is one of the major results that will come from further simplification.

As technique of production improves, intermittency in the use of equipment being eliminated, more expensive equipment, better suited to the standard product, can be bought, and cost reduction promptly follows simplification. The knowledge of the organization becomes specialized along narrower lines, and thus there is a tendency toward constant improvement of process. Simplification also brings with it production with less wastage of material. Thus, new styles of standardized metal beds use one-third less material than the old styles. Not only can equipment specially suited to the product be procured, but all equipment can be more easily assigned to the production of those numbers in the product to which it is best suited. Two machines of exactly the same type often show peculiar and unexplainable suitability for the production of different numbers of a similar product. With a reduction in the number of products made, it is possible so to control machine utilization as to take advantage of such conditions. Speedy and reliable delivery is possible even with reduced inventories because consumer demand can be more accurately gauged and production programs and finished stock adjusted to meet forecasts. Standards of quality and service come to be the basis of sales, instead of price shading and diversity. Because of the profit-making side of all these factors, the thoughtful general manager is likely to be enthusiastic over the development of a program of standardization of product wherever it will not so reduce sales as to vitiate the production economies which it produces.

The final success of such a program rests on the co-operation of the sales division or selling agent. Sales methods must be frequently changed, and, if not, the influence of the salesmen must be cast on the side of pushing sales of standard products rather than continually suggesting diversity. Co-operation between the sales and production divisions, through regular committees or through special conferences, is the first requirement in developing a workable program of product standardization. The development of a budget of sales and production, as explained in later chapters, is probably the best insurance of successful operation. If this is not practicable, then each item of the line should be carefully gone over in the conference between the two departments, and the requirements of each carefully understood by the other before items of product are either added or dropped.

Securing simplification. Some of the means that have been utilized by individual industries to secure simplification deserve some mention. These include the revision of sales methods, the development of a succession of designs where novelty is an important factor, and the development of parts standardization.

In changing over sales methods to effect simplification, the change is from arguments based on diversity and price-shading to arguments based on, first, better goods at the same price, or the same goods at a better price, due to manufacturing economies; second, service to the customer; and, third, if the product be sold through dealers, quicker turnover and hence, lower investment, damage, and obsolescence charges. Such vital changes in selling methods at times necessitate changes in whole mechanisms of distribution. As an example of this, Mr. Galliver will again be quoted:²

"Formerly we had a big line of kinds and grades to sell, but we scattered in the selling. One printer who was sold very early on our standardization policy declared that he would thereafter buy our product. But he found it not at all advisable at that time to carry out his resolution, for he would have had to buy of thirty-one jobbers, among whom the agencies for our various brands were scattered. It happened that of these thirty-one jobbers he was in the habit of dealing with only five. Now this demanded correction and we proceeded to correct it. We ceased dealing with thirty or forty jobbers in each district. Instead we selected the leading merchant in each district as the 'service house' for his district. He handles and stocks our complete line of all varieties and grades. Most of these merchants had made their prosperity in sales of their own brands, some of which had been made by us, some by others. Yet they were willing to give up many of their brands in favor of our mill brands, because they believed in the business value of standardization and simplification. Simplified lines have brought to the merchant the advantage of volume sales and his sales are easier. The sales of each standard grade build themselves up by the momentum of use. And each time a salesman makes a sale, the salesman sells the idea of the whole series of grades as a complete and integral service line. The work of our sales department has become much simpler. Its principal activity is now in rendering service, rather than manipulating orders. The service division is rapidly becoming bigger than the remainder of the department. The comparatively few merchants through whom we now distribute are now ordering with closer approximation to their needs, and withal continuously. The turnover with them has materially increased."

Style and simplification. There are many businesses in which the style factor is so important that whether or not there shall be profits is determined largely by the stylishness of the product. Unusual profits are made by initiating style or, as it is sometimes known, "beating the market." Such businesses are women's millinery and apparel. In such cases, standardization of product over a period of years cannot be thought of. Despite the importance of novelty, taste, and style, much progress

² System, September, 1921. (A. W. Shaw Co.)

can be made in the standardization of texture of materials, as contrasted with design, and with the inner portions of the articles manufactured. Wherever possible, the addition of certain staple styles to the line does much to bring to the plant the benefits of standardization. In such industries much can be done in insuring the elimination of designs of past seasons at the time that new designs are added, thus keeping the total line to a given number of patterns. This idea of succession of designs is very important in all industries where taste and novelty enter into retail sales. An illustration of this is found in the clock industry. The William L. Gilbert Clock Company of Winsted, Conn., desired to reduce their line of approximately five hundred pieces, which had grown up through the course of years by reason of the trade and the salesmen demanding something new every few months. They analyzed the sales of the various patterns and kept only such patterns as had been sold in quantity. By so doing the number of patterns was cut to approximately seventy-five. There was a continuous check kept on the product, so that when interest in a particular number lagged it was quickly dropped and a new design replaced it. Thus the line was rotated and yet standardization was achieved.

Parts standardization. Parts standardization is an effective way of simplifying the line if demands of consumers call for diversified lines, particularly in assembly industries. Products falling under this head includes shoes, furniture, and automobiles. The experience of a large stove manufacturer clearly illustrates this step in standardization. The first items standardized were stove lids and stove centers, the cross-pieces that hold the lids in place. There are from four to six of these on every stove, and the old method of making them was to have a different size cover for every stove. All types were abandoned except one, and this was made in 7-, 8-, and 9-inch sizes, thereby eliminating many patterns and much of the stock of castings. Next, the legs of the stoves were standardized. These were made in four classes, light legs and heavy legs, both with and without base strips. These four types were substituted for the great variety that previously existed. The bodies of ranges and cookstoves were next developed so that they could be trimmed with many nickled parts or not, allowing three grades of stoves to be made from one size of body. Many auxiliaries, such as towel rods, swing shelves, lifters, and handles were standardized for practically all types of stoves.

The automotive industry has been able to standardize largely through parts standardization. Absolute standardization of the finished product has proved to be impossible for any factory, because of the varying consumer demand for size, price, type of body, and color. Although selling phrases in the automotive industry are largely "carefully drawn specifications," "no radical change," "manufacturing economies due to large produc-

tion," nevertheless, in recent years style and color have been a large factor in sales. In order to develop style and standardization at the same time, the automobile has had an infinite amount of attention paid to detail standardization of its parts. The automotive industry, through the Society of Automotive Engineers, has led the country in developing standard specifications of bolts, screws, sheet steel, and other component parts.

In some very complicated industries, standardization has come about through the leadership of one company. Thus, in the pipe fittings and valve industry, the Walworth Company took a very conspicuous part in working toward simplification. It announced the elimination of sizes 4½", 7", 9", 11", 15", and 22" fittings and valves. Other manufacturers followed this lead in the elimination of excess variety with evident satisfaction, and the program was received with evident satisfaction by dealers and consumers as well. Mr. Howard Coonley, in commenting upon this step, said, "Of course this simplification of pipe sizes has an effect on every class of material we manufacture. We drop out iron valves, brass valves, steel valves, iron fittings, and malleable fittings; and the reduction in inventory made possible, is, in total, a very considerable item."

The movement toward product standardization. Large-scale adoption of programs leading to standardization of product by industries was first brought about in the United States through the action of the War Industries Board during 1917 and 1918. This board had found that one of the greatest obstacles to organization of the industries of the United States on a war basis was the utilization of time, material, and capital involved in unnecessary diversity of product. Starting with industries directly involved in the manufacture of war materials, it called conferences of leaders in each industry to develop a program for elimination of excess variety. Upon the basis of these conferences, action was taken. As an illustration of the enormous reductions in variety of product which were at this time brought about under the leadership of this board may be mentioned the reduction in the number of colors of men's hats to 9, as compared with approximately 100 distinct colors that several factories were previously producing. Another example is the reduction of rear gearings on farm tractors from 1736 to 16. Action in the case of industries closely allied with war operations was quickly followed by action in numerous other industries with a view to general conservation of plant capacity, materials, and man-power. Thus, after conference, the number of styles of chinaware was reduced to 330, a very considerable reduction from the 1130 patterns which one company had been producing.

The direct results of the action of the War Industries Board were not permanent. When freed from the war-time restrictions, many plants were

quick to return to the "liberties" incident to the production of great varieties of product. Many of the reductions which had been made were unnecessarily severe from the peace-time standpoint. However, many manufacturers, having tasted the benefits accruing from standardized production, endeavored to retain them. In the main, the war action has been felt in a continuing way through the action and efforts of the trade associations. Development of standardization programs represents an ideal field for the action of trade associations, and many of them have been leading their trades in the direction of product standardization during the last few years. However, not all standardization programs since the War have been developed through trade association action. For instance, Fayette R. Plumb, Inc., of Philadelphia, reduced their line of tools from 2752 items to 610 items, and were ahead of most manufacturers in the trade in the extent of reductions. The Walworth Company reduced their line from 17,000 to 610 major items, others being added only after general executive consideration. The John Deere Wagon Works went far ahead of the industry by reducing their farm-wagon line from 1200 to 90 and saving as a result \$90,000 a year on interest on tied-up capital alone.

Simplification within an industry is essentially a co-operative action, because one large company selling on the basis of diversity can make standardization very difficult for its competitors. The United States Chamber of Commerce, observing this, and seeing the advantages of simplification, undertook an educational campaign through its Fabricated Production Division, in 1920, organizing a movement which brought prompt results. In 1921 the Division of Simplified Practice of the United States Department of Commerce was formed, after which the United States Chamber of Commerce turned over to this new governmental agency the sponsorship of the movement, remaining itself in an advisory and supporting position.

The Simplified Practice Division, which has had the assistance of an advisory group, highly representative of industry, and including representation from the United States Chamber of Commerce, adopted a program of action upon the request of a trade group only, meanwhile conducting a wide educational campaign. The first step in this program was a survey of the industry, conducted by the trade, determining the number of current varieties and the demand for each. The results are studied by a simplified practice committee appointed by the industry concerned. A tentative program of elimination is formulated for presentation at a general conference composed not alone of producers and distributors, but also of consumers and neutral engineers. After formal acceptance of the recommendations by a substantial majority of interested groups and individuals, they are published by the department as one of the series

of simplified practice recommendations, subject to periodic revisions either by another general conference or by a standing joint committee of the industry.

The accompanying chart (Fig. 76) gives an excellent idea of typical reductions in product diversity through the organized movement toward product standardization.

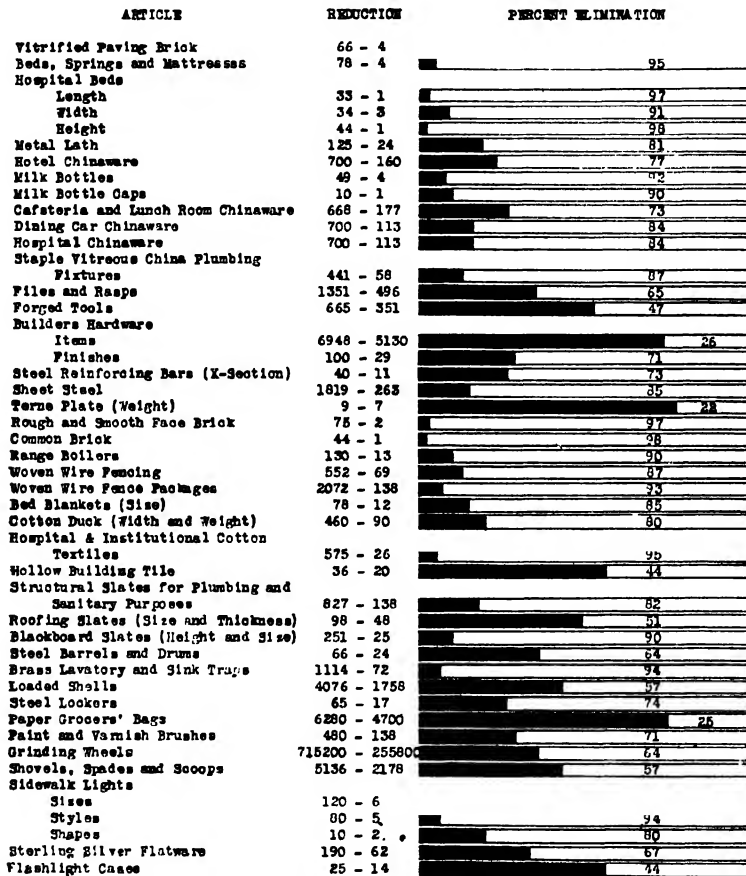


FIG. 76.—Chart Indicating Percentage of Elimination of Variety of Product in a Number of Industries.

Simplification is a particularly fertile field for trade-association action in industries in which the product of one factory becomes the raw material of the next. It is manifestly impossible for a plant manufacturing a primary product, or component, to attempt standardization of product if its customers are continually calling on it for diverse and unusual products to form the raw material for their manufacturing processes.

Thus, in the manufacture of wood wheels, the plants must be governed by the requirements of the vehicle manufacturers; and, in the manufacture of metal plates for pianos, the requirements of the various piano factories using the product must govern. Until the requirements of the latter (a wood-working trade) are standardized, the manufacturer of the plate (in a metal-working trade) cannot standardize his product. One manufacturer alone can do little under such conditions. A trade association which interests all its members in this subject, establishes standards, and works in conjunction with the trade associations of allied trades can do much.

Frequently it is necessary, in order to develop a standardization program, to effect a meeting of persons of seeming diverse interests, all of whom, however, are in a position to influence the possibility of standardization in the trade. As an example of this may be mentioned the manner in which standardization was brought about in the vitrified paving-brick industry. The first conference resulted in the reduction of the number of sizes of this product from 66 to 7, and these 7 were later reduced by other conferences to 4. Among the groups represented at the first conference, the presence of all of which was necessary in order to assure practical and lasting standards, were: American Association of State Highway Officials, American Ceramic Society, American Electric Railway Engineering Association, American Society of Civil Engineers, American Society for Municipal Improvements, American Society for Testing Materials, as well as representatives of the paving-brick industry, the Department of Commerce, and the United States Chamber of Commerce.

Effect of simplification upon the worker. A possible limiting factor in the extent to which standardization of product should be carried as a program for industry is the fear of the effect of continued development of standard product upon the worker. Many forward-looking manufacturers have paused to consider whether or not they should adopt a program of product standardization, lest they unwittingly be abetting the degradation of the worker. The point of view of those who oppose product standardization for this reason is that if the product be diversified, the worker tends to be a high-grade, skilled man, capable of diverse work. Such a man is likely to take interest and pride in his work and generally to be a useful citizen. As the product becomes standardized, the worker tends to become a low-grade machine tender, who does simple processes over and over during the day. There is thus likely to develop the type of man with little interest in the job, with practically no pride of accomplishment, and, in general, the type of worker who is easily swayed by movements leading to industrial or social unrest.

There can be no final answer given at this time to these contentions.

Even in extremely diversified production, the workman makes only his small portion of the product day after day. The difference is that he is making his small portion of a number of products rather than of a few. Besides, the skill of the old-type workman has been frequently over-estimated as the years roll by; and the newer workman has newer types of skill of which the old workman had none, such as skill in the manipulation of machinery.³

The change in type of workman with the standardization of product is a real one. As operations become automatic and repetitive, they can readily be performed by persons of less skill (even in machine operation). There can be no question but that the development of product standardization means the future development of automatic machinery to perform the operations in the manufacture of the standard product. But the usual process is not one of degradation of the skilled workman, but rather elevation of the unskilled man into a semi-skilled job. Standardized product means cheaper product. Cheaper product means wider markets. Product standardization is thus one of the most effective steps which can be taken towards an increase of business by a manufacturing concern. The effect on the production of the automobile industry which followed the standardization of its product is well known. Similar effects have followed every other successful attempt at standardization. Markets are expanded, luxuries made necessities, and jobs created for many more persons through product standardization.

Mechanization incident to product standardization is but a small step in the progress of the transfer of workers' skill which began with the very beginnings of the Industrial Revolution. Industries producing diversified products must mechanize almost as fully as those producing standard product. The use of process conveyors is not dependent upon the production of but a few sizes of products.

Unknowing people have been heard to inveigh against the "degradation of the worker" in the Ford plant; but they are usually persons who have never been through the plant. It does not take an expert in management practice to see that most of the operators on Ford machines and assembly lines would be in the labor gang were it not for the extent to which their work has become standardized. Unskilled men have been made semi-skilled men at high wages. And what has happened to the skilled man? He has become the tool-maker or the supervisor. The demand for skilled men is greater than the possible supply, and this demand is also to be found in the vendor plants which sell Ford standardized parts. These skilled men are needed in numbers that would be unthought of, were it not for the huge production demands made possible

³ See article, "Skill," by Anna Bezanson, In *Quarterly Journal of Economics*, August, 1922.

by the standardized car. And so it is with the whole process of standardization. If all our wants had to be filled by the production methods of 1750, the products would be so expensive that our wants would be nearly as small as those of the people of 1750. Every step in betterment of productive capacity means wider markets and, in the end, employment of more skilled men.

Another answer to the objector to product standardization is the answer to the objection that it kills the worker's initiative. By working on the same work day after day, the worker really can know that job and that machine better than the man who first developed them. He knows enough really to make suggestions that are practical and can be utilized. The worker who, working on the same task day in and day out, cannot find play for his initiative in suggesting improvements, has no initiative. There is a problem in insuring that the worker realizes his relationship to the industrial fabric as a whole, but that is true with division of labor under modern conditions, regardless of standardization. That problem will be discussed later, in the chapters which deal with the personnel policy.

There is one last answer to the objections. The tasks of a very large share of workers in industries are so constructed that they do not change whether the product be standardized or diversified. To the man working around the dye-vat in the hat factory it makes little difference whether there are hats of a hundred or of nine colors made. His task remains the same, and the technique of his job is not affected. The crew which stacks and fires the kiln in the plant manufacturing chinaware has the same problems and must go through the same work, regardless of whether 1130 or 330 patterns are made. Standardization of product only affects a small portion of the working force of any industry, and they are not adversely affected.

CHAPTER XVII

STANDARDS OF MATERIAL AND EQUIPMENT

The meaning and value of standards in management. Before discussing the various types of standards, it will be desirable to define clearly the word "standard." "Standard," under modern management, means a carefully thought-out method of performing a task, or carefully drawn specifications covering some phase of the business. These specifications may cover working conditions, equipment, some method of performing a job, or some article of material or product. Standardization does not imply that perfection has been reached. Nevertheless, after conditions or methods have become standardized, there usually follows a constant attempt to better the standards and raise them toward perfection. The standard is merely the best method, condition, or specification that can be devised at the time, taking into account all limiting factors. Improvements in standards are always desired and are adopted whenever they are found. Although there is nothing in the idea of standardization that precludes change, nevertheless standardization protects from changes which are not in the direction of improvement. Standards protect methods from change either for the sake of change or from the natural inclination to break away from set conditions through the usual laxity which may occur as work progresses.

To change a standard under modern management it should be necessary that the proposed change be scrutinized as carefully as the standard was scrutinized prior to its adoption, and further, that the change be brought about by persons as competent as those who originally framed the standard. Standards adopted and protected in this way produce the best possible results at any given time.

Standardization of product may or may not necessitate standardization of operations. It is possible, although not likely, that standardized product will be made from unstandard material on unstandard machines by diversified methods. It is more likely that product standardization will be the first step toward complete standardization of operations.

A standard is a base line for management. The setting of standards thus becomes one of the fundamental tasks in organizing a business for operation. The value of standards as base lines are four-fold. (1) They create a foundation upon which other steps of good management may be built. (2) The setting of them of itself causes a careful investigation to

be made into all phases of the business. Without such investigation standards cannot be intelligently set. (3) They tend to aid routine operation of the business, and thus the development of a system and the application of the exception principle of management. (4) They reduce costs of operation in a way peculiar to themselves, thus making possible reduced costs to the ultimate consumer, as well as increasing the profits of the business.

Frederick W. Taylor said:¹ "It was in the course of making a series of experiments with various air-hardening tool steels with a view to adopting a standard for the Bethlehem works, that Mr. J. Maunsel White, together with the writer, discovered the Taylor-White process of treating tool steel, which marks a distinct improvement in the art. The fact that this improvement was made, not by the manufacturers of tool steel, but in the course of the adoption of standards, shows both the necessity and fruitfulness of methodical and careful investigation in the choice of much neglected details. . . . The economy to be gained through the adoption of uniform standards is hardly realized at all by the managers of this country."

The conditions in American industry with regard to standardization have improved since Taylor wrote the above. This is particularly true in some branches of the metal-cutting industry. Much of the improvement can be laid directly, and much more indirectly, to Taylor's work. In many other industries, however, the setting and maintaining of standards has scarcely begun, and there is everywhere much opportunity for study and improvement in conditions.

The discussion of factory working conditions in previous pages brought out constantly the necessity for the development of standards of lighting, of movement of material, of air conditions, and of other similar phases of the plant itself. Analysis of these points will show that in attempting to better these conditions in reality standards are being set. The discussion of simplification has focused attention mainly on one phase of standardization, namely, the elimination of useless duplication of product.

Utilizing standard material. Analysis of the problems of material standardization will indicate the factors involved in applying standards to operations, as contrasted to organization or working conditions. It is impossible for production problems to be solved if the material that is being worked upon is not standard, or if the composition of the material is not known definitely. Naturally, it is not necessary that the best material be purchased. This would force all product to be high-grade, and afford no goods for those with low purchasing power. Therefore, standardization of materials takes the form of type standardization, regardless of whether the type be the most costly, but mindful of manufacturing problems.

The standardization of raw materials directly affects the operation of three branches of any manufacturing enterprise: (1) the purchasing

¹ Shop Management, p. 124. (Harper & Bros.)

department, (2) the manufacturing division, and (3) the sales division. If the materials bought are standard, the purchasing department is better able to keep abreast of market conditions, is better able to place large orders and thereby receive lower prices and larger discounts. It is also better able to keep in touch with the demands of the factory for raw material, and, hence, to lessen the likelihood of a partial shutdown because certain raw material is not available. The manufacturing division, by knowing that its raw material is standard, is better able to set standards of performance for its workers, is better able to plan the routing of work through the plant, and is better able to plan standard methods of performance as well as amounts of performance. The sales division, knowing that the raw material is standard, can demand of the manufacturing department that their work be standard and is, therefore, in a better position to talk the merits of the completed article to the customer with a knowledge that the article when it is delivered will conform to all the promises that they have made.

In the purchase of raw material it is essential for the purchasing department to keep in mind that it sometimes costs much more to work up a poor grade of material than it does a good grade. Regardless of the quality of the finished product, manufacturing costs on a poorer grade of material may be so much larger that they will eliminate all the prospective profits from the low price at which the material was bought. In practically every industry there are to-day means of measuring, testing, and observing raw materials and materials in process, which were not dreamed of ten years ago. Much of the recent research work in industry has taken the form of finding out fundamental facts concerning materials. Therefore, the manufacturer takes full advantage of the investigations that have been made, and insures that all raw material which comes into his plant shall be suited to his type of product and to the type of machinery which he employs to work it up. Thus a metal-goods manufacturer learns just what type of metal he needs by making hardness tests on those metals which in practice give the best results and those that do not, recording all data carefully.

Large companies maintain their own testing laboratories and staffs of scientists who develop material standards as well as new products. The electrical industry has come to be known as spending more than any other in this type of research, companies such as the General Electric Company spending millions of dollars a year on such tests. The age of national advertising has forced manufacturing companies to stand back of their product for many years, for sales years hence are dependent upon the lasting qualities of product sold to-day. With this in mind, the Victor Talking Machine Company has developed elaborate tests for materials that go into their stains, varnishes, and lacquers. Violet-ray tests are given materials that vendors submit to their purchasing agents, so that the action of these

rays may give evidence of the way that these materials would look twenty to thirty years later, if used in Victor finishes.

Service tests are often necessary in addition to laboratory tests. Particularly in industries in which standard grades are unknown to the trade, it may be wise to submit a sample of a prospective purchase to actual service conditions in the plant, and to measure the qualities of the material agreed to between the vendor and the user on the basis of this run.

U. S. Bureau of Standards tests. The United States Bureau of Standards makes about 200,000 tests of materials yearly, many on direct request of manufacturers. In order to promote wide use of the results of these tests, this bureau has recently adopted a so-called "certification plan." The Bureau compiles lists of manufacturers who have expressed their desire to supply material in accordance with certain specifications, and who are willing to certify to the purchaser that the material thus supplied is guaranteed to comply with the requirements and tests of the specifications. This is an extension of the service which the Bureau of Standards has furnished for some years to Government departments. A purchase of materials which is supposed to meet such specifications, by a company without its own laboratory, may now be checked easily by submission to a commercial testing laboratory, for the specification is standard. To the extent that the certification plan results in the standardization of commodities, its benefits are felt by all material users, whether they directly use the certified specifications or not. For some years some commodities, as for instance lumber, have been marked with the standard grade of an association, as the American Lumber Standards. It is not unlikely that many materials soon will be sold under a label certifying that they meet Bureau of Standards specifications.

When material standards are finally set for purchases of an individual company, it is essential that such standards conform to trade specifications, or the additional cost will be high. Such standards are more likely to fit the needs of the individual user because of the recent work of the Bureau of Standards and the American Engineering Standards Committee.

The American Engineering Standards Committee. This committee, with offices in New York, is a creature of the several technical societies, such as The American Society of Mechanical Engineers, The American Society for Testing Materials, and the Society of Automotive Engineers; a number of trade associations, such as the National Electric Light Association, the American Gas Association, and the American Railway Association; and a number of other groups interested in industrial standards, such as the National Safety Council, and the Bureau of Casualty and Surety Underwriters.

The purpose of the American Engineering Standards Committee is to develop standards for industry through mutual action. When a particular

type of standard is to be developed, a sub-committee is formed, with representation from all those interested in the proposed standard. Among those who receive such representation are the engineering society interested, manufacturers of the article, users of the article, and labor. When this sectional committee makes its final report, this is reviewed by the executive committee of the American Engineering Standards Committee, and if finally approved is adopted as American standard. Because of the manner of the deliberations, such standards find immediate acceptance in industry. Standards adopted cover a wide range, including safety standards; mechanical standards, such as strength, ductility, and physical content of various metal materials; and standards of equipment, such as sheaves and pulleys.

Operating standards as the basis of rate setting. Standards of material must be set and adhered to prior to studying methods of performing tasks or setting rates. It is clear that proper rates cannot be set if constant difficulty is encountered in working up material and if there are good and bad lots which alternately reach the same operation. Wage disputes in several industries, particularly the silk industry, have centered around this problem. If material be not standard, any attempt to place the workers on piece or bonus rates usually results in disaster. It is impossible to determine how much work should be done by the worker or the best way of doing that work, unless the worker is provided with equipment, the performance of which is uniform. The stories which "rate setters" in many manufacturing plants tell concerning trouble with belts, tools, etc., can generally be traced back to an absence of standards. Most of the injustice with which piecework has been charged is due to the lack of standards. It cannot be too clearly emphasized that many of the means used by managers to procure sustained production, such as proper production control and the newer types of wage systems, rest solidly on the initial provision of standards, both of equipment and of material. Men who aim to take short cuts in increasing production without attempting to standardize first, usually read failure into their efforts within the first few months of their experiments. The complaints of workers against so-called "scientifically" set rates can frequently be traced back to the fact that though the rates were properly set on the basis of the conditions as they existed at the time of setting, and as such were proper rates, these conditions changed, owing to lack of standardization, and the rates were not correspondingly adjusted.

Utilizing standard equipment. Equipment must be thought of as everything, except material, with which the worker is provided to aid him in the performance of his task. As has been indicated, the building itself is the most important phase of equipment, but usually it is not referred to as equipment. Equipment ordinarily includes all apparatus assigned to

production centers at which employees work, including workbenches or machines, and all tools, either separate from the machines, or fitted into them as particular jobs are to be done. As with materials, standardization of equipment is important, not only as a ground work for setting rates, but because of the economies of utilizing equipment suited to its tasks.

Workplace standardization. Workplaces may or may not include machinery, as the operation is a hand or machine one. In machine operations, the workplace is of a character determined by the nature of the



Courtesy Bayuk Cigars, Inc.

FIG. 77.—Standard Machines Make Standard Workplaces. Cigar-making Department Bayuk Cigars, Inc., Philadelphia.

machine. In tending spinning frames or looms the workplace does not usually include a chair as a portion of the standard equipment, because the nature of the operation does not give the worker much opportunity for sitting down. In many cases, six to eight looms are attended by a single operator, and the job consists largely of walking from one to another and determining that everything is running smoothly. On the other hand, standard machines working on products which allow the worker to remain seated permit the seating arrangements to become a portion of the standard workplace. (See Fig. 77.) Attention to the layout of production centers,

such as that which has been given in this illustration affords a high percentage of use of the floor space. It will be seen that the workplace afforded the several workers on a cigar-making machine includes a bed for working up tobacco for the worker who is preparing the filler (e.g., worker under section 102 marker); and standard containers for the workers who are inspecting the finished cigar as it comes from the machine (e.g., worker in lower right-hand corner).

Standardized workplaces come to be of particular value in hand work such as the assembly of small products. Figure 78 illustrates a standard workbench for the assembly of typewriters. Each of the small parts that goes into the final assembly has its particular compartment, built to fit. These compartments are so arranged that the article may be removed by

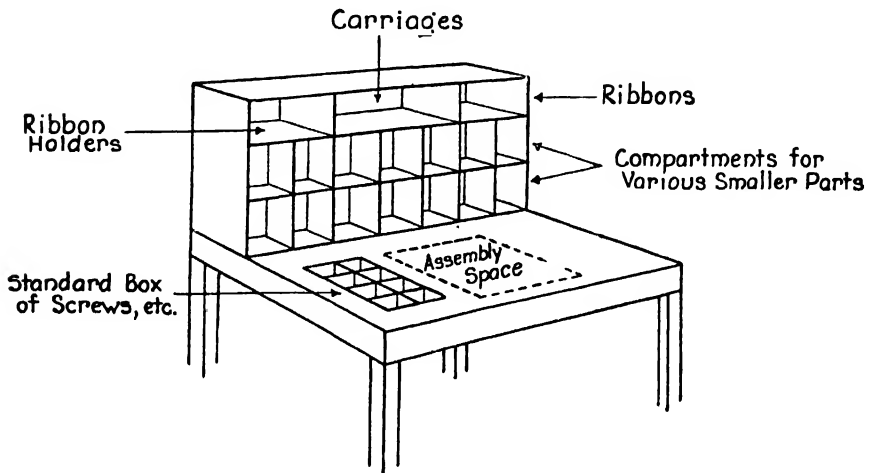


FIG. 78.—Standardized Assembly Bench, Corona Typewriter Co., Groton, N. Y.

the right or left hand, depending upon which should hold it while it is being assembled. Small screws and nuts are conveniently held by standard parts carrying boxes which fit into the top of the assembly bench. Such boxes for carrying small parts are provided for all assembly operations at this plant and many others.

Standard equipment. Equipment to hold parts for assembly has been developed by many companies to fit their particular needs. Figure 79 illustrates such a box, utilized at the Philadelphia plant of the General Electric Company in the assembly of small switches. A sufficient number of each part, usually 25, for each lot being manufactured, are provided. If one part be used twice in the assembly, for instance, a screw of a particular size, twice the number of this part are provided. Much study may be given the arrangement of the divisions of the boxes, so as to entail the

least labor in assembling. A similar type of box is the standard metal tote-box which has been developed to transport material from one operation to another. If these are of proper size they may be utilized for a standard number of each part. They are very sightly and durable and will nest one into the other when not in use, thus economizing both floor space and handling labor.

Standardization of the worker's chair, particularly of its height, has been given much study. In a factory where the work permits sitting, it will be found that if the management has not provided chairs, the workmen have improvised seats out of old nail kegs and packing cases, or have made themselves rough benches or stools. If the chairs are really an aid to the work, they should be furnished by the management and, as far as practicable, should be scientifically standardized and suited to the purpose for which they are to be used. It is in the telephone exchanges that the importance of a proper chair has been, perhaps, most conclusively shown. Endeavors to improve and speed up the service have resulted in close attention being

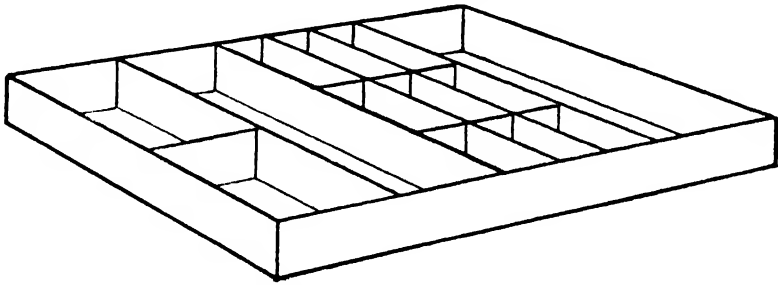


FIG. 79.—Standardized Box for Small Parts.

given to the proper type of chair, and the adjustable-height, back-fitted chair that is used in all exchanges to-day, was developed and has become an enormous aid in the handling of the great traffic passing over the large city switchboards.

The problem of finding the proper chair affords scope for considerable thought and ingenuity. For instance, to gain the advantage of sitting when the work requires moving about, the Waltham Watch Company has fitted with wheels the chairs of those who tend groups of automatic watch lathe benches. Close to and paralleling the benches, a rail has been laid which guides the grooved wheels on the front legs of the chairs while the rear wheels roll on the floor. But small effort is required on the part of the operator to pull herself along from machine to machine.

The proper height of the workplace and the chair depends largely on the nature of the work. Generally speaking, on heavy work, it is desirable to keep the lifting distance small. On the other hand, workers seated on ordinary chairs should not be required to bend too much; or

when the material handled is quite light, it may be profitable to allow the height of workbenches to be determined by the machine-bed level of nearby machines. Transfer trucks or tables on wheels of the same height can then be employed and the bench hands provided with higher chairs. This arrangement has been found to be profitable in the finishing department of one large paper company and has expedited considerably certain operations which must be carried on both on machines and on benches.



Courtesy Royal Metal Manufacturing Co.

FIG. 80.—Standardized Commercial Factory Chair.

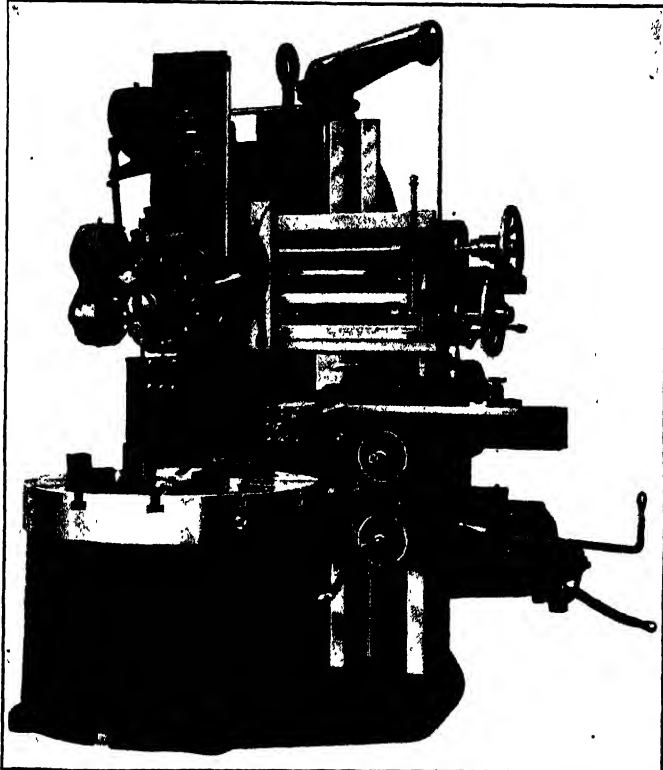
One of the most satisfactory forms of commercial factory chairs is illustrated in Fig. 80. The broad saddle seat, the adjustable legs, and the close-fitting back make this exceptionally effective. Footrests may be needed, but these can be readily attached. The chairs in Fig. 77 are similar to that just described. Such equipment is of particular value when women are employed, as has been demonstrated through surveys independently made by the State Departments of Labor of New York and Pennsylvania, and by the General Electric Company.

Standardization of machines. In quantity production of standard goods, which is typical of the manufacturing of to-day, it is in machine standardization of all equipment that the greatest strides have been made. Chapter XI dealt largely with standard conveying equipment, utilized largely in such industries. But it is in the development of the machine itself that skilled labor has been displaced, and production costs lowered

most through standard equipment in such industries. From the standpoint of the machinery manufacturer, machines are standard or special, depending largely upon whether they are general-purpose machines, to be sold to customers for a wide range of work (see Fig. 81), or machines which are constructed for some particular operation (see Fig. 82). Standardization of machinery, from the standpoint of the user, means fitting machines better to perform the particular work to which they have been assigned.

There is thus some conflict between the desires of machinery manu-

facturers, attempting to secure the economies incident to standardization of product, and those of the user of the machinery, anxious to use machines that are especially adapted to the tasks to be performed. However, since the machinery manufacturer gains repeat orders from the low production costs at his customers' plants, resulting from the use of his machines, this question is usually decided by the machinery manufacturer adapting some standard machine to the particular purpose at hand. An excellent illus-



Courtesy The Bullard Machine Tool Company.

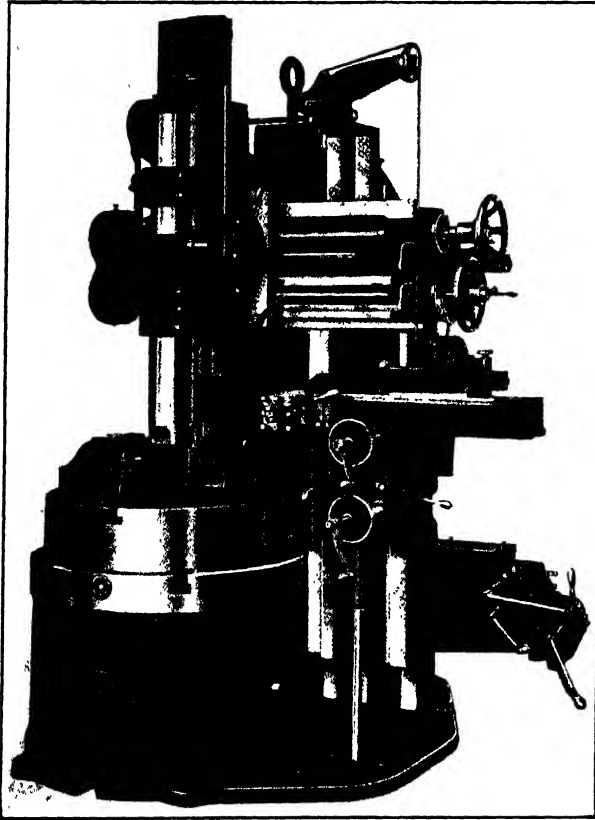
FIG. 81.—Bullard 42-inch, Spiral Drive, Vertical Turret Lathe for General Service.

tration of this is found in Figs. 83 to 85. Figure 83 shows a Bullard Mult-Au-Matic machine tool. This machine has been developed to fill the needs of simultaneous machining operations under modern industrial conditions. It will accomplish a series of simultaneous machining cuts, consisting of boring, turning, facing, or similar operations, on a series of identical pieces in process, the production time for the completed piece being the production time for the longest operation. Even this compli-

cated modern tool can be specialized to meet particular manufacturing processes. Figure 84 shows this tool adapted to machine differential carriers in an automobile plant. This machine has the characteristics of the standard Mult-Au-Matic, but has been so modified that it is of practical use for only one purpose. Figure 85 shows a close-up of the diversified

tooling of this special machine, which has been standardized to meet the conditions in the user's plant.

Some of the factors which will determine whether general-purpose or special machinery will be used are as follows: (1) the production economies that may be secured by the special machine, such as the grouping of several operations in one tool. These economies are dependent on the degree of refinement which is justified by the quantity of production involved. The total quantity of output and the degree of standardization of product which has been achieved are both factors. (2) The difference in the initial cost, the general-



Courtesy The Bullard Machine Tool Co.

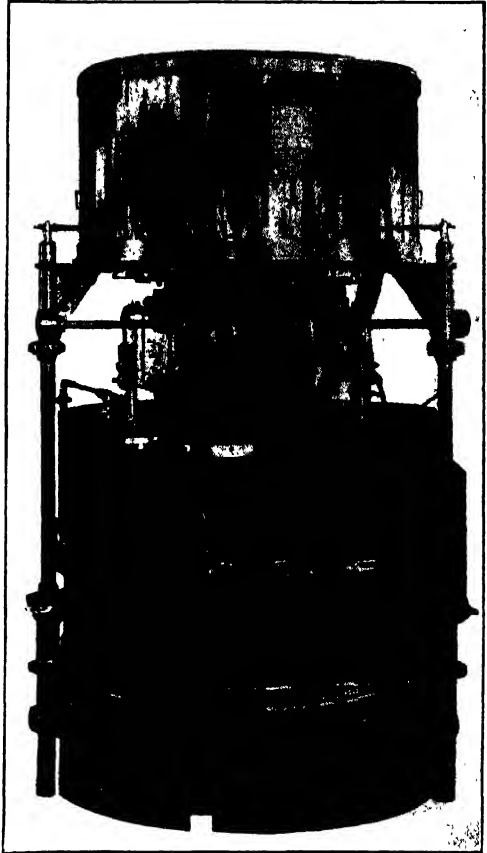
FIG. 82.—Bullard Borer and Facer for Locomotive Driving Boxes. A special machine useful only on driving boxes or similar work. An adaptation of the general-purpose machine illustrated in Fig. 81.

purpose machine usually being cheaper, because of economies in its manufacture. (3) The likelihood of change in the manufacturing program of the user. Special machines are difficult to adapt to new product. This has caused some manufacturers to demand that, when special-purpose machinery is purchased, the cost shall be saved by production economies in twelve to eighteen months.

In attempting to apply the idea of standardization to machinery, the costly error of over-equipment is likely to be made in order to secure like machines within a department. Thus a number of expensive machines, each of high capacity and expensive to operate, may be bought, whereas a few of this type of machine might suffice, while other machines of smaller rated capacity could perform the remainder and larger proportion of the work at less cost. The advantage of flexibility of planning the work would have to be great, to overcome the investment and operation costs of the larger machines.

Regardless of whether standard general-purpose machines or standard special machines be utilized, there are a number of steps toward the standardization of the machinery to fit particular operations to be performed, which may be taken after purchase. One such step is to make inexpensive changes in pulleys or gears, better to fit the machine to particular operating conditions. General-purpose machines must be geared by the maker so as to perform a wide range of duties; and if they are to be used on specialized work, it is frequently profitable to change their gearing. If two general-purpose machines of different makes are to be utilized on the same work, it frequently will be found advisable to standardize their range of speeds and feeds, which may vary greatly.

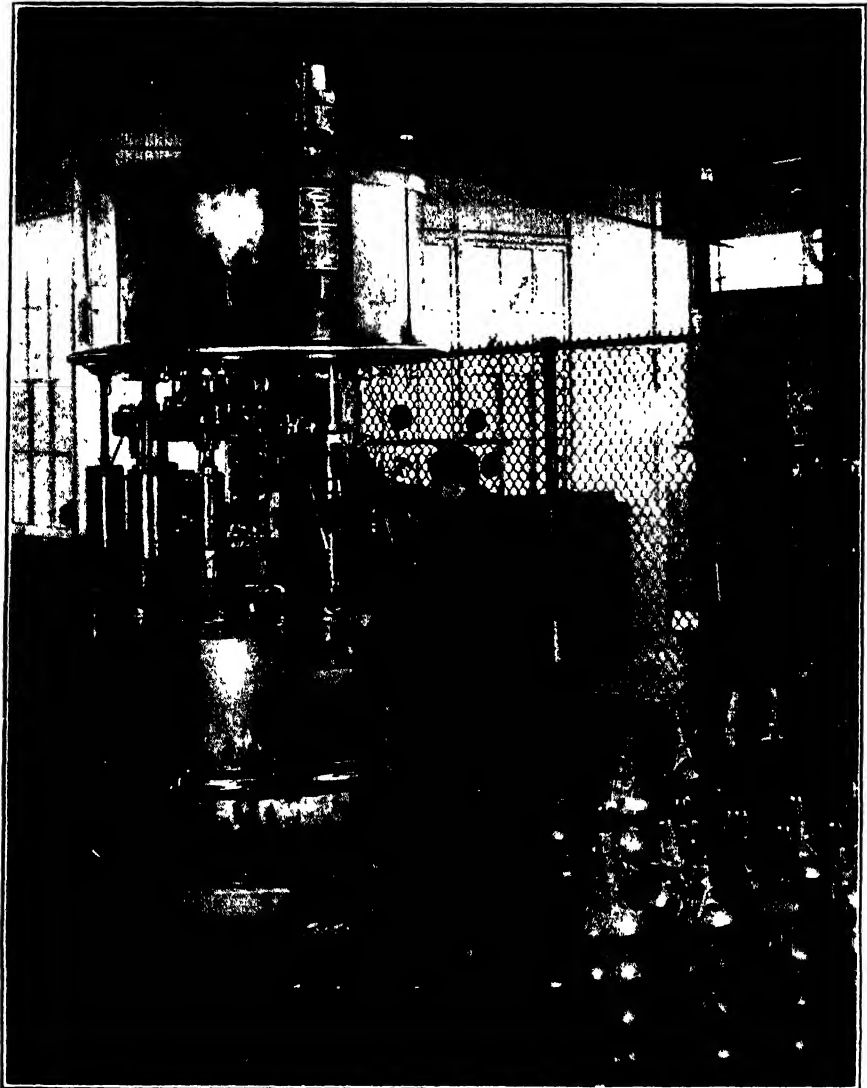
Power-transmission. The most general lack of remediable standards will be found in the speeds at which machines are operated. Frequently this lack of standards is due to the power-transmission lines. In mills where several lines of shafting drive identical machines, variations of as



Courtesy The Bullard Machine Tool Co.

Fig. 83.—Bullard Mult-Au-Matic. A manufacturing method performing five simultaneous machining cuts.

much as 10 per cent in the speeds of the line-shafts are common. In some factories variations of 60 per cent have been found between the speeds of

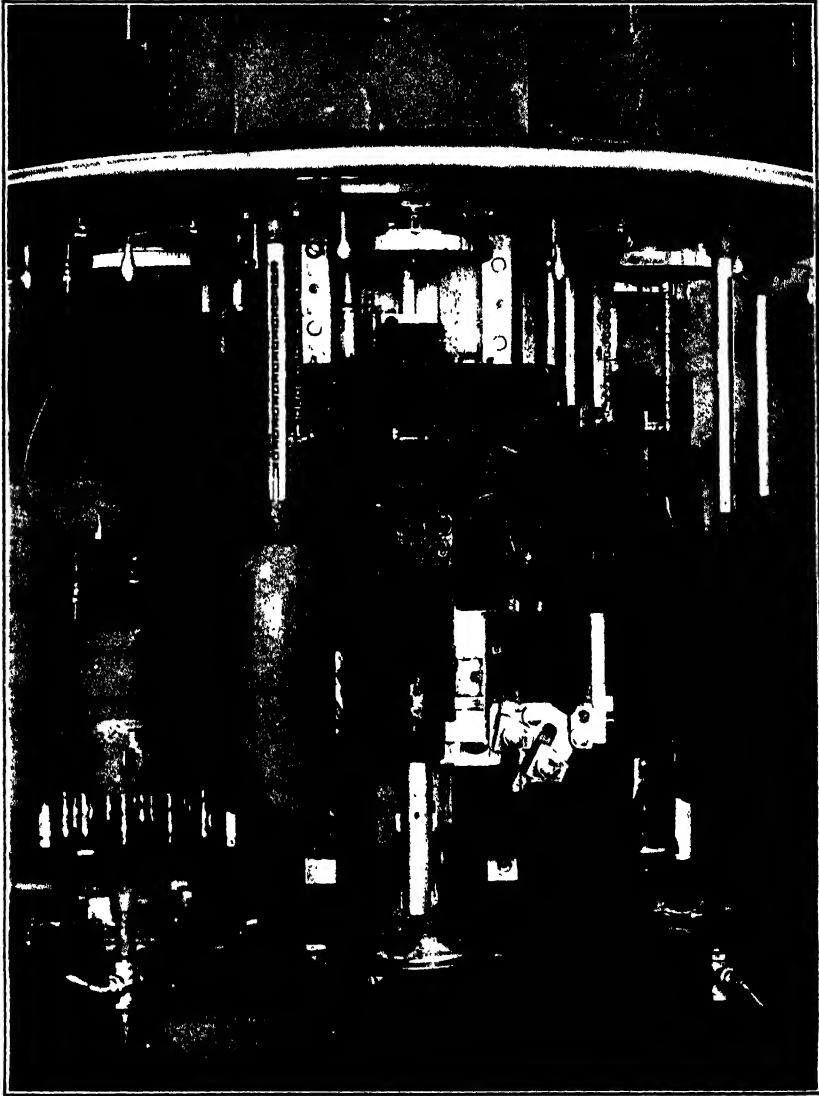


Courtesy The Bullard Machine Tool Company.

FIG. 84.—Bullard Mult-Au-Matic Adapted to Special Machining of Differential Carriers.

identical machines working on the same job. This is due partially to the variation in the speeds of the shafts, and partially to the condition of the belting. The beginning of belting standardization came about when the

belting manufacturers began to see that they were frequently supplying



Courtesy The Bullard Machine Tool Company.

FIG. 85.—Close-up of Tooling on Special Bullard Mult-Au-Matic for Machining Differential Carriers.

different sizes and grades of belting to different manufacturers to do exactly the same work. The belting manufacturers then began to inves-

tigate and ascertain which type of belt did the better work, thereby beginning a study which has resulted in the supply of standardized belting for nearly all transmission needs. All the requirements of power-transmission fall into a number of sharply defined classes, for each of which a standard may be set up. Belt engineering departments have been established by the larger belting manufacturers, and the factory manager who desires to drive his machines from line-shafting has at his call, if he desires to use it, a whole mass of accumulated data, which gives him the necessary information as to just what standard belt he should use for any given purpose. Tables of belting performance have also been worked out by the belting-manufacturing companies which may be taken advantage of by the factory manager.

Standard tools. Standardization of tools began with the experiments of Frederick W. Taylor at the Bethlehem Steel Company on the use of that commonly used tool, the shovel. He showed that workmen to be most effective in their work, must have a type of shovel which peculiarly suited the material which they were handling. His experiments indicated that a shovel-load under ordinary conditions could best be handled if it consisted of about 21 pounds. It therefore followed that a shovel which was to be used in iron ore must be of a different size from one which was to be used for ordinary dirt, and a shovel which is to be used in moving coal must be smaller than one used for moving ashes, if the 21-pound load is to be secured in all cases. To many people in industry, despite these experiments, a shovel is still a shovel. Frequently no particular attempt is made to see that the laboring gang is provided with different types of shovels, based on the material which is being worked on, or what is being done with it. Nevertheless, great strides have been made in numerous cases, and, particularly in the contracting business, there has been much attention paid to the proper type of shovel.²

In the usual types of factory work, it will be seen that there are two general kinds of tools used on most jobs, first, the auxiliary tools that are used in the preparation of the job and its removal from the machine and, second, the actual tools used as a part of the machine in the performance of the operation. The auxiliary tools in some shops have been considered to be about as humble as the shovel and as little susceptible of scientific study. To see a high-priced machinist, who operates a machine tool on which the overhead machine rate is also high, spend fifteen minutes trying to get a bolt ready to hold his work on a machine is the best possible argument for the standardization of auxiliary tools and for the practice of storing and issuing them to the workman along with the material to be worked on, as is

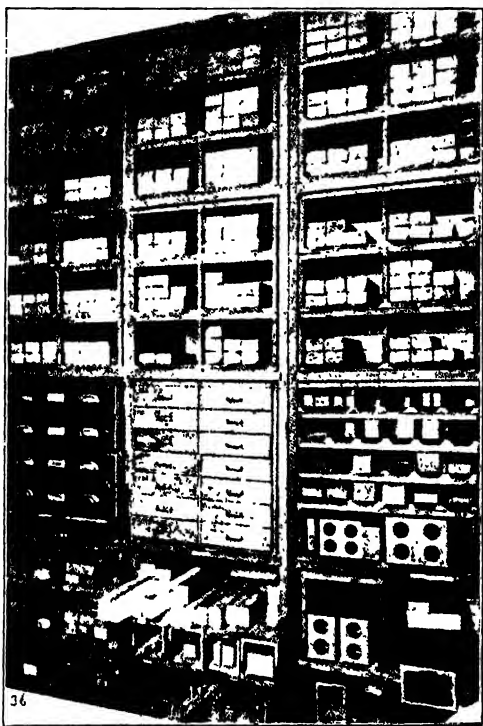
² See "Modern Management Applied to Construction," Hauer, D. J., McGraw-Hill Book Co.

done with the operating tools. Figure 86 illustrates proper storage of such tools.

Fastening-tools in machine-shop work may be given much attention, not only to insure their being available when wanted, but also to see that they are of the right type and are in good condition. Frequently the preparation time for operations is almost as long as the time taken for the operation itself. Therefore, proper auxiliary tools, which are usually inexpensive, will quickly become real money-savers. All industries employ auxiliary tools, such as wrenches and screw-drivers, which can be readily standardized.

One of the greatest profit-making auxiliary tool types is the jig, or fixture used to guide operating tools, particularly drills, so that their operation shall be the same on each piece. Careful analysis of production methods will usually provide the stimulus for jig development, particularly if an operation involves any cutting or drilling. A similar illustration is to be found in the clothing industry, where in the cutting operations, the familiar patterns have been amplified in some plants by designs, showing how they may be best laid out on cloth of different widths in order to conserve material. In metal-

cutting, considerable ingenuity is frequently called for in the design of jigs. In one plant it was found necessary to drill five holes of two different sizes on two sides of the same piece of metal. A two-spindle drill was used. Small one-piece jigs were designed to fit over two sides of the piece of metal. The operator first places the jig over the piece, then quickly places the piece under the spindle holding the larger drill, drills three holes, then, without moving the jig, places the piece on its side under the other drill, drilling two more holes. All five holes are quickly and cor-

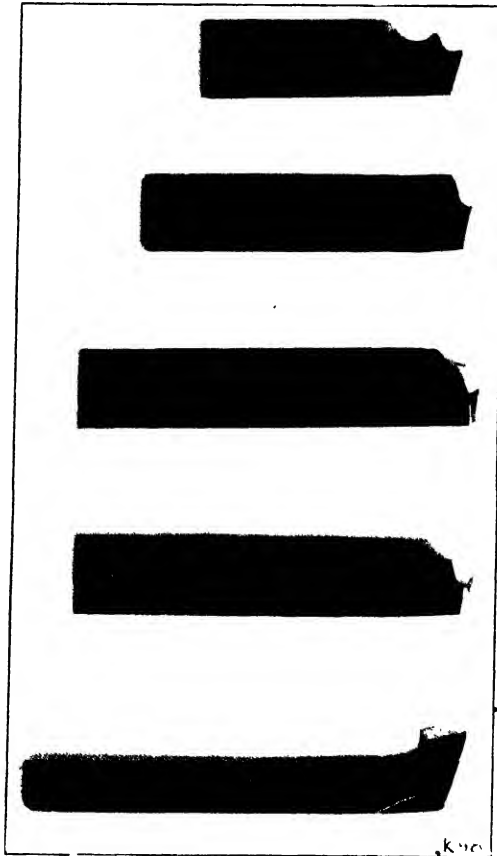


Courtesy H. K. Hathaway.

FIG. 86.—Section of Tool Room, Showing Standard Bins and Woodblocks Stored in Standard Bins.

rectly guided by the jig, which the operator now removes and places over the next piece to be drilled.

The operating tools in a machine shop consist of cutting tools that go into the machine and are changed with each type of job which is put into the machine. The composition of these cutting tools varies greatly, and



Courtesy H. K. Hathaway.

FIG. 87.—Lathe Tools (Side View). The bottom one is standard tool-machine ground; the others unstandardized-ground by hand of workmen.

was completely revolutionized some years ago with the discovery of high-speed steel. New inventions are being perfected yearly, and it is not at all uncommon to find a number of types of tool steel in stock in a shop. The presence of a large variety of types of tool steel in a shop is very desirable. However, some steps must be taken to insure the use of tool steel of the proper grade on each job. To leave this to the workman is to leave it to guesswork. Many shops can still be found in which tools made from a dozen different qualities of steel are used side by side, in many cases with little or no means of telling one make from another. When one realizes that the cutting speed of the best air-hardened steel is, for a given depth of cut, feed, and quality of metal being cut, say, 60 feet per minute, while with the same shaped tool made from the best carbon tool steel and with the same conditions, the cutting speed will be only 12 feet per

minute, it becomes apparent how necessary is careful attention to the utilization of the right tool on the right job. Carbon-steel tools are still used for many operations, as in accurate finish-cuts.

Tools are different, not only in composition, but in the method of grinding. The cutting edge was in past years largely put on the tool by the workman at the job, and he was accustomed to grind this edge entirely

with respect to his own whims and prejudices. It can readily be seen that to use a tool ground the wrong way is quite as bad practice as to use a tool of the wrong composition. There is a certain shape of tool best adapted to each individual kind of work, and the tool should be ground at certain definite angles which have been found to be the best by a long series of experiments. It is obvious that if all tools are to be ground to these correct angles, the responsibility for the grinding of them must be taken away from the men in the shop and placed in the hands of a man in the tool room. Figure 87 shows the wide variations found in cutting tools used for the same job in one shop, compared with a tool for that job properly ground to conform to best practice.

In weaving, much attention can be given to shuttles, to insure that they are standardized. The use of shuttles of different weights, with the same speed of the loom, produces a variation in the tension on the filler thread. Smashes and stoppages in production often may be traced to this cause. Shuttles must not only be of standard type, but must be kept in good repair. In spinning and weaving, the speed at which the machines can be run will be found to vary with the product being manufactured and the quality of the material. Studies may be made which will give the proper operating speed, in picks per minute, for each type of fabric being woven. A pick counter, mounted on the machine, will materially aid in securing this information.

CHAPTER XVIII

MAINTAINING STANDARDS—THE INSPECTION DEPARTMENT

THE maintenance of standards of material or of product is largely in the hands of the inspection department. The inspection department is in a peculiarly favorable position to effect large savings in operation through vigilant upholding of standards which have been set.

If the inspection department must uphold general standards of manufacture, as provided for by the manufacturing policy that has been adopted, this implies not only upholding standards of materials or product, but also upholding standards of exactness which allow for interchangeability in manufacture and for proper handling of later processes and operations. This responsibility which is placed on the inspection department is very likely to cause the inspectors to be looked upon by production men as opposing forces. Unless careful consideration be given to methods of operation, the inspection department and the quantity production group are very likely to become bitter plant enemies.

Location of the inspection department in the organization. As has been pointed out in Chapter VI, an inspection department must never be made directly subservient to the will of those who are engaged in increasing the quantity of production. Unless quality of work is but a very small factor in the successful operation of a plant, the following scheme for the location of inspection work should be avoided.

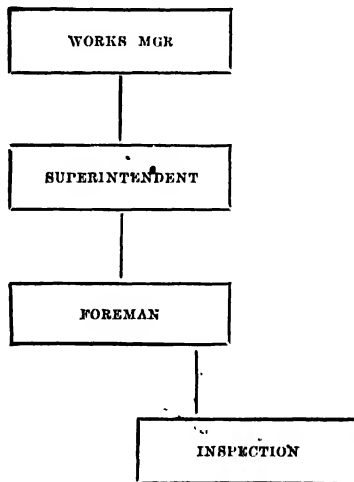


FIG. 88.—Poor Location of Inspection Department in Organization.

If the foreman has charge of inspection work, manifestly he cannot be expected to be rigorous in his application of manufacturing standards and, at the same time, be forcing quantity production through his department. This does not imply that the foreman should not be interested in quality. Means should be provided to see that quantity production should not be credited to a foreman unless quality is good. On the other hand, decision as to quality must be taken out of his hands.

If quality is not of excessive importance in an industry, inspection forces may be maintained as a staff department under the superintendent, as illustrated in Fig. 89. This places the foreman in a position

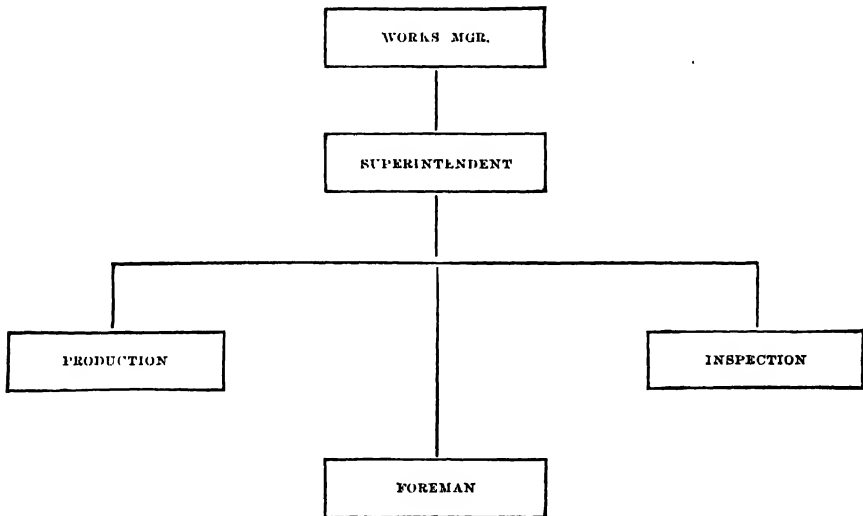


FIG. 89.—Location of Inspection Department. If Quality is Not of Excessive Importance.

of receiving instructions, as to amount of product to be produced and the quality of that product, from two sources. He must endeavor to correlate his instructions and, in case of conflict in instructions, the matter will naturally be referred to the superintendent for decision.

If quality is of maximum importance, as in the case of production of scientific instruments, or in goods which are sold mainly on the basis of quality rather than on the basis of price, the inspection department should probably become a major manufacturing function directly under the control of the works manager (Fig. 90). The inspection function would thus hold a position analogous to that of the purchasing department or the engineering department on the typical organization chart (Fig. 5).

The inspection department can be most helpful when it endeavors to prevent errors in manufacture, rather than criticize results and turn

back defective material for reworking or scrap. Though all errors cannot be corrected prior to their occurrence, if the inspection department will practice preventive medicine on the product, not only will it become a dividend-paying portion of the organization, but it can more readily co-operate with the quantity subexecutives. The inspection department is an effective aid to the foreman, the planning department, the training department, or the methods department, whichever of these may direct the methods of operation and instruction of the worker. If instruction as to causes of defects be made a major function of the inspection department, the idea of carrying on the preventive medicine campaign will have been greatly furthered.

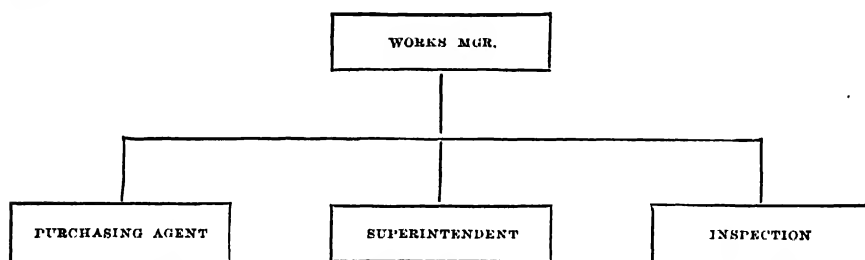


FIG. 90.—Location of Inspection Department. If Quality is of Maximum Importance.

The inspection department should have full control, both over inspection of purchased materials and parts, and over inspection incident to production. The first enables it to maintain the material standards which have been set, and the second makes possible the maintenance of product standards. Frequently the work of inspection incident to production will closely approximate the type of inspection on purchased materials. An instance of this is found in the case of a part to be made from soft steel for economical working, and then to be hardened and tempered to fit it for the service requirements of the finished product. This illustration should indicate the necessity of an inspection department having full control of all inspection operations.

Inspecting materials. Material purchased according to standard or specification must be inspected before acceptance. In some plants the foreman who is to use the material is required to inspect it, while in others a complete laboratory is at hand under the control of the inspection department. The inspection department, in general charge of quality of the product, is the logical place to have this inspection performed. Numerous supply items, such as electric-light bulbs, warrant only a casual inspection to find whether there are any broken or defective parts, and this is often taken care of by some member of the receiving department. In many instances, however, the inspection should call for checking as to quantity,

weight, quality, and workmanship. The best intentions of the purchasing department may be rendered void without an adequate inspection system. For example, the dimensions and weight of bar steel are easily arrived at, but the question of quality can only be truly determined by laboratory test. There are many cases in which chemical or mechanical tests are essential to ascertain whether stores are in keeping with the standard ordered. It is but natural that certain material may pass the original inspection and yet develop defects during the course of manufacture. A record should be kept of such instances with a full description, so that adequate tests may be provided the next time to detect the defects before the material enters the factory. It is a costly practice to allow material to be worked on in the factory before the weaknesses are discovered.

Manufacturing inspection. Inspection problems in assembly industries are somewhat different in character from inspection problems in continuous industries. In the latter, the general problem of manufacturing inspection is to develop good quality in the final product. Frequently the purpose of the inspection work is to rate the product as to quality after it is produced. In continuous industries, such as the manufacture of paper, textiles, or chemicals, a defect in manufacture is likely to make the material a "second," and there is frequently no possibility of correction of the defect. Thus the operation of an inspection department in such industries includes prevention of defects wherever possible, noting of defects after they have occurred, and decision as to whether such defects may be remedied or whether the goods must be placed in the lower classification of product.

In assembly industries inspection includes attention to accuracy of manufacture and to interchangeability. The American system of manufacture has been erected on the basis of interchangeable parts. Although the consumer is likely to look upon interchangeable parts from the standpoint of possible availability for repair purposes, this is a very minor consideration. From a production control standpoint, as well as from the standpoint of the assembly operations, this interchangeability of parts in assembled products is essential in order that specific parts, when started in manufacture, need not be designated as being for specific pieces of final product. Thus, in the manufacture of watches, from the consumer's standpoint the interchangeability of parts is important in those parts which become broken, such as springs. Nevertheless, this is of but small benefit to him contrasted to the benefits resulting from lower cost of manufacture due to the manufacturing interchangeability of practically every part in his watch, although some of the parts, because of their nature, will never need replacement during the life of the watch. Inspection of components during process affords the inspection department an especially good opportunity to practice preventive medicine in assembly industries.

The three major problems facing those who are developing the operating methods of an inspection department are when, how much, and how to inspect.

When to inspect. Decision of when to inspect cannot be made without considering the importance of quality in the product, and the possibilities of reworking the product after the various operations. It is easy to set up so many quality checks that the responsibility for quality is shifted in reality from the shoulders of the workers and foremen to those of the inspection department. This is fundamentally wrong, as, even in those industries which have the fewest quality demands, the workers should be held responsible for quality within the set limits.

Inspection must be made of the final product before it is shipped to the consumer or sent to stock. Perhaps inspection must be made after each operation. Between these two extremes lies the usual situation. In some industries inspection is so important for the following operations, and for the maintenance of product standards, that it must be regarded as a process in the manufacturing cycle just before assembly operations. The time of workers on assembly operations must not be taken up with the rejection or fitting of parts. Usually a series of operations can be grouped, and the product inspected after the last of this group of operations. However, after any operation in which the worker is not able to measure quality exactly, inspection must be made.

How much to inspect. In high-quality products, or products which are manufactured largely through skill of the worker rather than skill of the machine, much more of the product must be inspected than in the case of lower-quality product or in cases where the machine, once set up, is likely to turn out standard-quality products for a considerable time without adjustment. In the latter case, inspection must be made frequently enough to ascertain that the equipment is operating satisfactorily and does not need adjustment other than the usual adjustment made by the worker on the job. In the former case, frequently 100 per cent inspection will be necessary, that is, every unit of product must be inspected after every operation.

Sampling is a means of greatly reducing inspection costs, provided that proper checks are instituted. Inspectable product, under sampling, may be inspected while in production, by checking some of the pieces that the worker has just finished, or the product may be inspected in an inspection department after the operation has been completed on a given lot. On continuous processes, such as those which use process conveyors, check inspection is made by a walking inspector who may come to any point of the line at any time and check a unit of product at any point of completion. One method of checking sample inspection is to over-inspect lots which have already been inspected, another is to have all an inspector check through a

lot which he has already handled, after the lot number has been changed so that it will not be recognizable.

The percentage of product to be inspected is partly a matter of the judgment of the works manager, and his wishes, along with those of other executives of the company. Thus, many makers of tissue products only sample check the production, but the Scott Paper Company, of Chester, Pa., pride themselves on the evenness of the paper in the roll, and the exactness with which the outer wrapper is put on. Therefore, they inspect each roll of paper, and each individual inspector has final authority, throwing out any rolls that his judgment indicates are bad, into salvage boxes for dumping back into the beaters.

Inspection of parts produced on assembly lines. With a group of men on an assembly line, producing a part or completing an operation together, it becomes unnecessary to count production except at the end of the line. Hence an inspector may be stationed at the end of the line, who not only inspects, but counts the number of good pieces for which credit will be given. In case any parts are thrown out for defects, it is the practice to require the line to make the repairs without extra compensation. This makes for worker inspection as the processes are being carried on. However, on intricate assembly lines, such as a motor assembly, there must be floating inspectors who inspect periodically at the end of one or more of the group of operations.

How to inspect. Inspection department operation is facilitated through the development of an inspection code which is known to all concerned. This inspection code, which should be developed in writing if possible, should indicate the standards which are set up and also should indicate to the inspector the most frequent causes of defects in manufacture. A code should be rigid as to requirements, but the requirements should be reasonable in order to secure the co-operation of others in the production end of the organization. The inspection code, of course, becomes in a sense the code of the organization with respect to standards of material and of product. This code aims to indicate clearly the manufacturing standards, which may differ by certain differences or allowed errors from the standards as set up in the design or engineering departments. Although the latter department may indicate tolerances on its specifications, nevertheless there can be frequently set up in the inspection code the practical application of these tolerances.

Manufacturing tolerances should be set up with great care in order that unnecessarily high precision, and attendant high manufacturing costs shall not be required. Carefully studied tolerances will prevent these wastes of unnecessarily high precision. But the limit, as set up by the tolerance, should not be looked upon as the dimension or quality to aim at. Many manufacturers have frequently made the mistake of working to outside

limits, with large rejections as the result; in other words, they have aimed at the outer circle of the target, rather than at the bull's-eye. Although the shot will count if it hits the outer circle, nevertheless it will hit the target more frequently if the bull's-eye be aimed at. The best workmen in plants with the best production and inspection policy will hit the bull's-eye often, and they will not require decisions of the Supreme Court of the manufacturing department to determine whether or not operations which they have performed fall within the tolerances which have been set up.

Quality is a variable, and exactness of measurement is oftentimes questionable. Although tolerances are adopted as a means of quality control, still there may be means of saving units which do not come within the allowable limits. Therefore, rejects of valuable parts should be over-inspected, perhaps by line production men, to determine if it is worthwhile to try to save the unit by a special manufacturing process.

On units manufactured by setting up a machine, and then producing from that machine on a quantity basis, a first inspection should always be made as the machine as soon as the first few units have been made. This will insure that the set-up of the machine is correct, and therefore, that any defective units will come only from some change from the set-up, or through neglect on the part of the machine operator.

On machined parts, "Go and no-go" gauges that are set at the proper limits provide a quick way of checking the parts without gauge adjustment. Many devices can be set up in the inspection cage or on the inspection bench which will determine positively whether a part is good or bad, without elaborate adjustments. Particularly on standard production, as much attention may be given to elimination of labor in inspection, through mechanization, as in production.

An inspection department may be organized by having inspectors in charge of each operation, department, or unit of product responsible for that type of product, and reporting to a chief inspector only on matters of broad inspection policy. Or the department may be organized by having a large number of inspectors of meager authority do the physical work of inspection, calling the attention of over-inspectors to defects, or having their work checked by over-inspectors. This is particularly applicable in large companies which must have inspection departments with a rather large personnel.

Any inspection system should certainly provide for tracing defects to the individual worker who caused them, and should provide some means of insurance against their recurrence. Such methods tend to make workers their own inspectors, make possible the reduction of the inspection force, and provide for the smoother flow of materials through the manufacturing processes. Such a system should be tied up with some scheme of reward

for quality or penalty for failure to reach standard quality, as is explained in the chapters on wage payment, and particularly Chapter XXVIII.

Inspectors may often do other necessary work at the same time that inspection is carried on. Thus inspectors may count units of production, such computation to be the basis of wage payment for the operator. Inspectors of finishing operations may band, label, stamp, or wrap the final product in addition to inspecting it. This is particularly true in cases where the inspection is non-technical in nature, and may be done by the usual type of shipping-department employee.

In general, the inspection department must be constructive in its operation. It must not only reject, but must also show the causes of rejection, and it must work with and through the foreman in attempting to eliminate these causes. Disputes between the inspection department and the manufacturing departments cannot be avoided, but they can be minimized. They cannot be avoided because the inspection department is in reality absorbing all the difficulties which, were it not for its presence, would become interdepartmental disputes. Those plants which have large numbers of interdepartmental disputes between manufacturing departments concerning the quality of workmanship on material passed from one department to the next are usually plants in which the inspection department is not functioning effectively. Disputes between manufacturing departments and the inspection department may be minimized through taking two main steps. These are: (1) setting reasonable, definite, and measurable standards of quality variation; (2) using measuring devices of such precision as to render the method of determination of these quality factors acceptable to everyone.

CHAPTER XIX

CLASSIFICATION

MANY phases of organization operation and control are assisted by the development of an adequate classification for the business. A classification is a detailed, orderly arranged list of all the items pertaining to the various phases of a business. Classification, under modern business conditions, is a necessity, and the merits and results of classification should not be confused with the merits of the various systems of symbolization which make the classification usable in the day-by-day operations of the business.

The beginning of classification work within a business usually marks the beginning of accurate knowledge concerning the various phases of the business and their inter-relationships. It was previously pointed out that one of the operating fundamentals of good organization is the establishment of a complete and accurate set of records which will serve as the basis for action. These records must be obtained in a way which will permit those in charge of the work to collect the desired information rapidly and be assured of its completeness and accuracy. When one considers the number and variety of records that are necessary in the modern organization, it becomes apparent that a definite classification of the data pertaining to the various activities is necessary. Otherwise, there is likely to be duplication and overlapping of work in the collection of such data. The establishment of a classification within a business makes possible the establishment of a system which makes record-collection routine. In this and innumerable other ways, the development of a classification is a highly important part of the creation of an effective system within an organization.

The uses of classification development are as follows:

1. It clearly indicates the plan of organization, in that it shows the relationship of divisions and departments, and interprets the limitations of their activities.
2. It establishes a method for obtaining the information necessary for the operation and control of an effective accounting system, because it facilitates the collection of data pertaining to indirect expenses and manufacturing costs, and aids the

establishment of monthly inventory balances of Stores, Material in Process, Worked Material Stores, and Finished Products.

3. It aids in standardizing the arrangement of articles in store-rooms and prevents the incorrect issuing of articles, which often happens when names or shop terms are used on the requisition.
4. It furnishes a means for routing and controlling material in process by accurately designating the materials, machines, workplaces, and operations entering into each process or component.
5. It makes possible the collection of detailed information relative to buildings and equipment.
6. It provides a logical system for the filing of all data.
7. It aids the development of standardization. The word is here used in the special sense of the determination of the best method or the best material to use for any given purpose under existing conditions, and strict adherence to that best as a standard until a better standard is found. The necessity for standards in order to facilitate and cheapen production has been previously pointed out. Classification aids in this because in almost every instance in which classification is applied, it will be found that there are a large number of almost similar articles used for similar purposes. In order to reduce the amount of classification work, to say nothing of other reasons, there will be a tendency to reduce the number of items. This helps to create standards. When it is ascertained that an item is the best, it is adopted, classified, and recorded. The advantages of standardization alone will often more than cover the cost of classification, because the mere reduction in diversity of stores, products, or machines to a comparatively few standard ones is an economy of apparent value. •

Steps in the development of a classification. The first step in the development of a classification is that every element of the business must be listed with infinite detail, taking into consideration all existing departments, all materials in stores, and in process, all finished products, all workplaces and machines, all operations performed, all fixtures and tools, all buildings, and all possible sources of expense. After the preliminary data have been gathered, the subjects to be classified are divided and grouped into a number of main classes, each of which is designated by either a number or a letter, depending on the method used. Each

main group is then subdivided or further described to the extent that is necessary. After each group and subgroup has been formed and carefully revised, the attaching of symbols to each item may begun.

The cost of classification is heavy, although the return on the investment is large. Therefore, care should be taken to classify and symbolize no more of the business than will actually be daily utilized when the standard nomenclature has been built up. There are certain fundamental features of classification which can be used in almost every case, but there are others in which nicety of judgment must be exercised before deciding whether to incorporate them into the original classification or not. For instance, almost every plant has need for some control over its raw materials or parts in process in the storeroom. To secure this control it is necessary to establish a requisition method of withdrawal from the storeroom. As soon as this is introduced, standard nomenclature generally becomes a very useful mechanism, both for the location of the article itself in the storeroom, and for the abbreviation and simplification of the clerical work attached to the writing of the requisitions.

An example of when not to use too much classification occurs in almost any of the continuous or analytical industries which handle a single material from start to finish. In such a case an elaborate classification for routing, including identification of all materials in process, finished product, machines, and workplaces, might be expensive, burdensome, and unworkable. On the other hand, a highly involved assembly industry is lost without a good routing classification. The classification of duties and functions of individuals has not been carried as far as the classification of the other branches of industry. In a good functional classification, the duties of every individual in the organization are included in the classification in such a way that they are easily understood, and furnish the basis for other classifications used.

A classification should be made as simple as possible. Care should be taken not to subdivide the main groups any more than is actually necessary; otherwise, the symbols will be long and possibly unwieldy. Nothing should be included in the symbol that does not serve a definite purpose. On the other hand, the simplification of the classification should not be carried to such an extent that confusion or misunderstanding will result. The possibility of having to expand the classification in the future, due to a growth of the plant, should be borne in mind when the original classification is made, and provisions should be made to take care of such growth. Otherwise, the development of a new classification may be necessary, thereby incurring unnecessary expense and inconvenience in the operation of the business.

After a classification has been completed, it will be well to bear in mind that many unforeseen "kinks" will probably develop, and provi-

sions should be made for quickly investigating and correcting any trouble. A classification is useful only to the extent to which it is kept up to date. An accurate record of all persons holding copies of the classification should be kept, so that when changes are made in the original classification, arrangements can be made to have all additions and changes entered on all copies. This can best be handled by the Methods or Research Department, if one exists.

CHAPTER XX

STANDARD NOMENCLATURE

THE requirements of daily operating conditions demand the application of a standard nomenclature to the items that have been arranged through the development of a classification. Something more accurate, shorter, more concise, and less ambiguous than names or words is necessary. Such requirements are met through the use of symbols.

Symbolization. Symbolization is the assignment to all classified items of a series of related characters, in such a manner as to aid in the recognition of the item and definitely to fix its identity separately from all other items in all phases of the business. The completed set of symbols comprises a system of standard nomenclature for a business.

There have been a number of effective methods devised for the development of standard nomenclature, some of which are in common use. The two main methods utilize, respectively, as the base of the symbol system, numbers and letters. Both methods frequently use the main device of the other to aid in the expression of particular conditions. Methods utilizing numbers may be again divided into straight numerical systems, and Dewey Decimal Systems which express relationships by the positions of numerals to the left or right of the decimal point. Both are developed along essentially the same lines. Methods that are based primarily on the use of letters are ordinarily called mnemonic, because they are designed with the primary idea of having the symbol easily remembered.

Compromise is the basis of the art of working out of standard nomenclature. Deviations from a strictly logical series of symbols are often necessary to preserve a logical classification, which is more important. Effective symbols should be as short as possible, should be absolutely definite, so that one symbol can mean one and only one thing, and should be as mnemonic as possible.

Numerical symbols. The numerical system of symbols is used in a large number of businesses. With this system, the symbol may consist of one or more separate numbers. For instance, expense items are frequently designated by indicating the number of the unit of the business incurring the expense, followed by the symbol representing the expense. Whenever this system is utilized, a block of consecutive numbers is usually assigned to each general class into which the activities of the business are divided. The advantages of the numerical system are: (1) its seeming simplicity at first glance, (2) its ready adaptability to use in connection

with tabulating machines, (3) its particular simplicity when only accounts are classified. This last factor is the cause of the almost universal adoption of the numerical system when only accounts are classified. The disadvantages of the numerical system, compared to the use of letters (usually termed the mnemonic system) are the following: (1) it is difficult to associate the symbol with the item classified, which factor is particularly important in items of stores, product, etc.; (2) each position in the symbol only gives the possibility of 10 class divisions, while there are 22 in the case of letters; (3) because of the use of numbers for all purposes, sizes cannot be readily shown in the symbol; (4) in stores or production control work, the symbols tend to become extremely lengthy; (5) it is difficult, if not impossible, to develop a series of symbols to cover all the items in the business without repetitive numbers. These disadvantages are somewhat modified in case of the manufacture of standard product, where the number of items to be classified is somewhat less.

The Dewey-Decimal System, while essentially the same as a numerical system, is not so well adapted to business as to library work, because of the likelihood of misplacing the decimal point that is used.

The following is an extract from an example of the development of a numerical nomenclature:

DEPARTMENT NUMBERS (1-199)

EXECUTIVE DEPARTMENT (1-9)	GENERAL OFFICE (40-49)
1. President's Office 2. Vice President's Office 3. Treasurer's Office 4. Secretary's Office	41. Stenographic Section 42. Mail Section
COMPTROLLER'S DIVISION (10-19)	MAINTENANCE DEPARTMENT (70-79)
11. Credit Department 12. Accounts Payable Section	71. Machinery Section 72. Equipment Section
SALES DIVISION (20-29)	PRODUCTION CONTROL DEPARTMENT (100-109)
21. Domestic Sales Department 22. Export Sales Department 23. Sales Promotion Department	101. Planning Department 102. Standards and Methods Department

ASSET ACCOUNTS (200-299)

PLANT (200-224)	CURRENT ASSETS (260-271)
201. Land 202. Buildings Etc.	261. Cash—General Funds 262. Cash—Cashier's Fund Etc.
EQUIPMENT (225-234)	INVESTMENTS (272-279)
226. Machines 227. Motors	273. Sinking Funds 274. Contingent Funds

LIABILITY ACCOUNTS (300-399)

FUNDED DEBT (300-309)	
301. Bonds	332. Capital Stock Premium (Subscribed) Etc.
302. Coupon Notes Payable Etc.	CAPITAL STOCK (350-359)
UNFUNDED DEBT (310-329)	
311. Bills Payable (Notes)	351. Capital Stock, Common
312. Accounts Payable (Vouchers)	352. Capital Stock, Preferred Etc.

REVENUE ACCOUNTS (400-499)

401. Profit and Loss	403. Sales
402. Manufacturing	Etc.

EXPENSES (500—)

501. Salaries—Executives	511. Traveling
502. Salaries—Clerical	512. Entertaining
503. Commissions	513. Miscellaneous Labor Cost
504. Retainers—Premiums, Bonuses	514. Janitor Service

In the utilization of this classification, departmental expense symbols are formed in the way that the following examples indicate:

- 23502—Sales Promotion Department Clerical Salaries
- 23511—Sales Promotion Department Traveling Expenses
- 101504—Production Control Department Bonuses
- 102501—Salary, Head of Standards and Methods Department

Numerical symbolization of material is extremely common, and is especially valuable in cases of the manufacture of a few standard products for which standard materials are utilized in manufacture. In such cases, effective numerical stores symbols can be built up. Although there is nothing in the symbol itself which recalls the article referred to, nevertheless, constant association of the symbol and the article soon makes possible the prompt association of the article and the symbol name by those who daily utilize the symbols. An example of a stores classification, numerically symbolized, is not given, since it merely involves the numbering of the articles of stores and product in sequence, after they have been classified.

In plants manufacturing diverse products it is extremely difficult to build up a simple and effective series of numerical symbols for stores. Symbols soon become involved; and since they do not readily recall the article they describe, and, furthermore, usually duplicate other numerical symbols used in other phases of the business, some form of mnemonic symbol is usually adopted. As an example of the manner in which numerical

stores symbols become readily involved, the following symbol used by a paper-manufacturing plant is given: 801-2-3-0-5-16. This symbol was used to designate coupon bond paper, loft dried, second quality, glazed finish, weighing 16 pounds to a folio.

Machines are ordinarily classified by an arbitrary assignment of numbers to classes of machines and individual units within the class. The first two numbers usually indicate the class of machine and the last two the machine number within the class, as shown by this example:

0501—Automatic Feed Turret Lathe,	1
0502—Automatic Feed Turret Lathe,	2
2902—Gear Cutter	2
3601—Plain Vertical Milling Machine,	1

Some plants put department numbers in which the machine is located as first digits in the number of the machine. This is inadvisable, since when machines are moved from one department to another the symbols not only cease to have any meaning, but are confusing.

Mnemonic nomenclature. Probably the best type of nomenclature yet devised, which meets all requirements in practically every case, and is of great practical value, is the system based on the use of letters with the aid of numbers, commonly called the Mnemonic System. This system was worked out by Frederick W. Taylor and his associates, and their pioneer work in nomenclature stands as the best single contribution to nomenclature work in American industry. One of the most valuable phases of this type of nomenclature is that a system can be devised to classify and symbolize every single phase and item of a business in a way that makes the nomenclature a unified whole without repetition of symbols. However, in any business, only those items for which there is need of standard nomenclature need be classified and symbolized.

This system is based on a complete and exhaustive analysis of every detail of labor, materials, and organization involved in a business. All the elements are divided into logical groups, first into broad general divisions and then into subdivisions, groups, sections, subsections, and so on. Letters are used to designate each division, subdivision, group, etc. Where possible, the letter chosen is the initial letter of the name of the item or some significant letter in the name. Numbers are used to designate dimensions, job numbers, or lot numbers, depending on their place in the symbol. Numbers are also used to designate different items within a class. If there were eight or nine kinds of plain office pencils in a store-room, numbers would be used to designate the various kinds instead of going to the detail of adding a letter for each variety. With this last condition as an exception, letters and numbers are thus, wherever possible, suggestive of that which they represent.

Since one classification and system of nomenclature is to be provided for all items of the business, a base sheet can be drawn up indicating the first letter, or main classification, of each phase or item of the business. Such a base sheet is shown as Fig. 91. This base sheet indicates that the various activities of the organization have been grouped under three main heads: B, Business Division (including Personnel); C, Selling Division; and D, Manufacturing Division. In case some other phase of the business is made a main division, it, too, should be given, on this base sheet, a primary letter to designate it, as E, Engineering Division. A is reserved for the General Accounts of the business, X is reserved for all tools, Y for all machinery, and Z for all buildings. These last three letters may represent either the physical item or the account covering this item. No confusion can exist here because of the absolutely different usage involved. The letters from F to W, inclusive, are reserved for products, with the exception of S, which is reserved for Stores or raw material. Semi-finished material is represented by subdivisions of the product symbols, F to W. This reservation of letters will apply only to the first letter of a symbol. The letters I, O, Q, and U are never utilized in mnemonic classification, since the first three are likely to be confused with numerals and the last is likely to be confused with V.

General accounts, represented in the main classification by symbols beginning with A, may be symbolized as illustrated by the following example:

GENERAL ACCOUNTS

AA	Revenue Accounts	AM	Material Accounts
AB		AN	Unfunded Debt
AC	Current Assets	AP	Plant Accounts

After these main subdivisions of accounts have been made, actual accounts may be symbolized by further subdividing these divisions mnemonically, or by merely adding account numbers after the two-letter symbol. Inasmuch as mnemonic symbols are utilized less for purposes of designating accounts than for any other purpose, no further examples will be given.

Organization nomenclature. The following method of building up mnemonic symbols may be used in designating the various portions of the organization which have been classified. The nomenclature thus developed indicates immediately the relation of each unit of the organization to the organization as a whole. It is useful from that standpoint in the day-by-day operations of the business, as well as for expense division and distribution.

ITEM CLASSIFIED	DATA FOR CHARGING OF EXPENSES
A—GENERAL ACCOUNTS	<div> <div> General Expense Selling Expense Shop Expense Engineering Expense </div> <div> ← ← ← ← </div> <div> If both questions are answered NO then the charge must be against DEPARTMENTS </div> </div>
B—BUSINESS DIVISION	
C—SELLING DIVISION	
D—MANUFACTURING DIVISION	
E—ENGINEERING DIVISION *	
<div> F G H J K L M N P R </div> <div> } PRODUCTS </div>	<div> 1ST QUESTION ← Begin Reading </div> <div> Is the expenditure one involving work on product to be sold? </div> <div> <div>NO →</div> <div>← YES</div> </div> <div> Worked Materials or Product which will ultimately be sold to Customers </div>
<div> S—STORES </div> <div> T V W </div> <div> } PRODUCTS </div>	
X—FIXTURES, TOOLS	<div> <div> + 0 - </div> <div> 2ND QUESTION </div> <div> Does the expenditure increase the permanent value of the Plant? </div> <div> < YES) — (NO → </div> </div>
Y—MACHINERY, MOTIVE POWER	
Z—BUILDINGS	

* If main division; otherwise under manufacturing.

+ Partly charged to asset accounts and partly to shop expenses.

0 Construction or addition to equipment which wholly increases permanent value of assets.

BASE SHEET FOR MNEMONIC CLASSIFICATION

FIG. 91.

B—BUSINESS DIVISION

BF	Office Manager	BT	Cost Accounting Section
BG		BV	Miscellaneous Business
BH	Cashier	BW	

OFFICE MANAGER'S GROUP

BFA		BFM	Mailing Unit
BFB		BFN	Messenger Service

D—MANUFACTURING DIVISION

DA	Auxiliary Departments	DM	Milling Department
DB	Blacksmith Shop	DN	Foundry
DC		DP	Punch Press Department

Expense nomenclature. Expenses incurred may be designated by the use of one of the following symbols, placed after the symbol of the department, division, or shop responsible for the expense. If there be fear of confusing the expense symbol with a designation for the subdivision of a department, zeros may be inserted, and the expense symbol thus always appear in the fourth, or other predetermined position. Example: BFOA-Salaries, Office Manager's office.

A	Salaries, Commissions and Wages	M	Machinery Repairs and Maintenance
B		N	Retainer—(Premiums, Bonuses)
C	Consulting (including Legal)	P	Power Transmission

Where further subdivision of these expense charges would be desirable, this might be best accomplished by numerical subdivision before the letter designating the expense, as:

1A	Salaries, executives	5A	Janitor Service
2A	Salaries, clerical	6A	Material Handling Labor Cost
3A	Commissions	7A	Crane Operator Labor Cost
4A	Miscellaneous Labor Cost		Etc.

Thus, clerical salaries for the planning department would be segregated under the symbol DAP2A, and janitor service for the whole shop would be DOO5A.

Product and worked material nomenclature. The nomenclature of product and worked materials under this scheme is provided for by symbols beginning with the letters F to W inclusive, with the exception

of S. Thus, in a plant manufacturing miscellaneous types of locks, the product classification might be as follows:

F	N Night Latches
G	P Padlocks
H	R

In many cases where a plant manufactures one composite product, such as an automobile, it is desirable to treat that product as two or more distinct things, such as chassis and body. The important point about setting up a workable product classification is to visualize every group which goes into the final assembly. These groups are then broken up into divisions, sections, and subsections.

To illustrate the methods of classifying and symbolizing these groups and sections it is advisable to follow through the construction of nomenclature for one of the products enumerated above. Selecting padlocks, it is first ascertained that there are various kinds of padlocks, as follows:

PD	PR Railroad Switch Padlocks
PE	PS Steel Padlocks (Except PH)
PF	PT
PG	PV
PH Heavy-duty Padlocks	PW

The final product symbol is thus seen to be actually represented by two letters rather than one.

Selecting heavy-duty padlocks, it is found that these are manufactured by assembling, in final assembly, several subassemblies, as follows (see Fig. 92):

PHB Back Assembly	PHM Miscellaneous Assembly (Separate parts going into final assembly)
PHD Dog Assembly	
PHL Bolt Assembly	PHT Tumbler Assembly

The back group or assembly is composed of a number of parts, which, for convenience, may best be expressed as numerals, placed before the last letter. If the product were more complicated, and were composed of a number of subassembly sections, which were in turn assembled into the main subassembly, there might be four or five letters used, so that all these might be symbolized. In such a case, the components of the last subassembly would again be designated by numerals placed before the last letter. The back group may be designated as follows:

PH1B Back	PH4B Shackle Post
PH2B Case Stud	PH5B Dog Stud
PH3B Bolt Spring Post	PH6B Shackle Spring Post

Unless the purpose of developing such elaborate symbols is briefly

considered at this point it may seem that they are unnecessarily complex. Each part which goes into the final product must be made, usually by performing several operations. It must be routed through the plant and assembled with other parts to become a portion or whole of the final

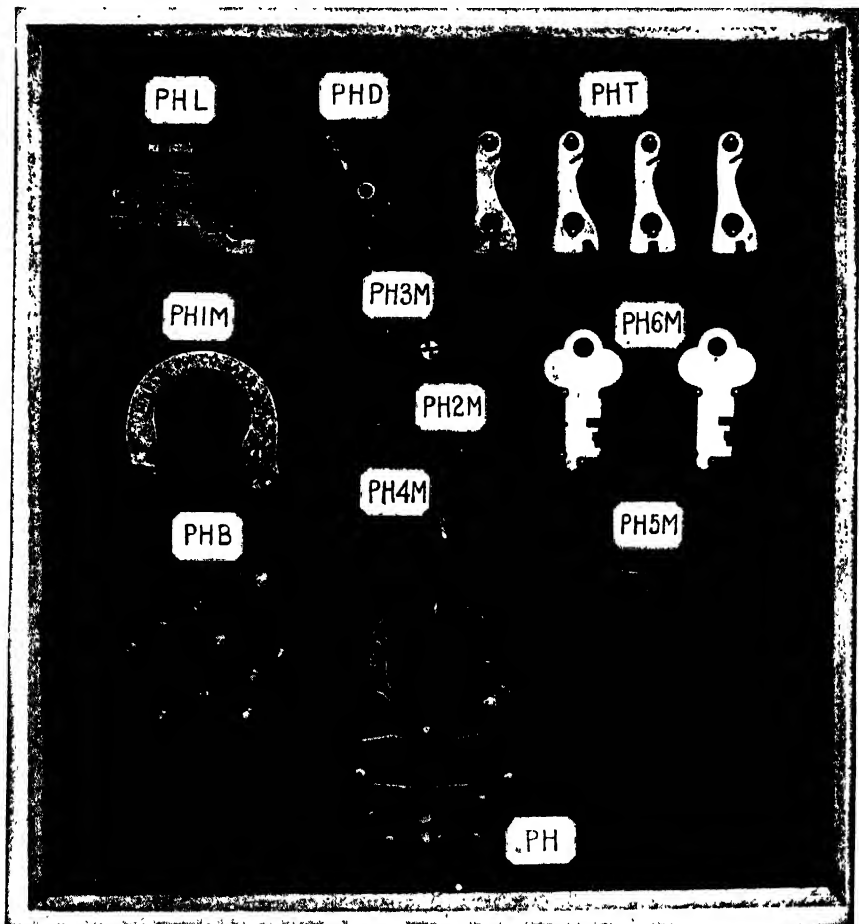


FIG. 92.—A 2½-in. Heavy Duty Padlock. Finished lock (with front cut open), sub-assemblies and components entering into final assembly. (The symbols used are not those of the Miller Lock Company, manufacturers of the lock, this lock having been selected to illustrate mnemonic nomenclature and routing because of its extreme suitability.)

product. As such it must be controlled, and to be controlled it must be designated in some manner, either by a name or by a symbol. Furthermore, all parts must be stored at times, and yet be readily available when wanted. Some designation must be attached to each part, in order

that it may be stored properly and designated in such a manner that it will be readily available or can be separately accounted for. The system of symbols being described, in addition to fulfilling all these requirements, readily shows the relationship of one part to another.

The worked-material symbols can be arranged to show dimensions or size of the product, so that the different varieties of similar products may be distinguished. Thus, if the product be a $2\frac{1}{2}$ -inch heavy-duty padlock, the symbol becomes P $2\frac{1}{2}$ H. This size designation will be carried by every part going into the lock, as P $2\frac{1}{2}$ H1B, back for $2\frac{1}{2}$ -inch heavy duty padlock.

The worked-materials classification serves as a means of designating shop operations. This is accomplished by inserting the number of the operation, in the sequence which makes the piece, in front of the piece symbol. Thus 1P $2\frac{1}{2}$ H1B is the first operation in the manufacture of the back for the lock. The second operation in the final assembly would be 2P $2\frac{1}{2}$ H.

The worked-materials symbol may be utilized also to show the lot number of any order in process. This may be accomplished by the addition of the lot number at the end of the product or worked material symbol. Thus P $2\frac{1}{2}$ H7 represents lot number 7 of $2\frac{1}{2}$ -inch heavy-duty padlocks.

From the foregoing it becomes apparent that there are certain rules of number utilization in mnemonic symbols which have been built up on the basis of long and hard experience. First, only operation symbols may be used as prefixes to worked-material symbols. Second, care must be utilized in the insertion of dimension numbers before the last two places of a worked-material symbol lest these be confused with the part symbol. Third, numerical parts of the worked-material symbol may not be placed after the last letter, as this place is reserved for lot numbers.

Stores or raw-material nomenclature. It is in the classification of stores or *Purchased Materials* that the greatest possibility for variations in the methods of classifying is found. Because articles are bought from several manufacturers under different names, though the articles may be the same or similar, an additional difficulty is faced. Because of the choice of methods, and the possibility of ambiguities in the classification, it becomes essential that every detail be carefully guarded. Those articles which are special rather than standard articles of stores are not classified, but are given serial numbers prefixed by the letter "S." Thus, S1242 is an article carried in stores only temporarily, which is not a standard article of supply in the plant. This saves unnecessary work in classifying, and at the same time an automatic signal is provided to prevent the article from being carried too long. It will also help to indicate automatically when too many of a special article are on hand.

The two general methods of stores classification are:

1. Classification of materials by their nature.
2. Classification of materials by the use to which put or the purpose served.

The former permits a classification that is universal in its nature, and is probably necessary in very large, complex plants. When carried to its logical conclusion, it results in somewhat longer symbols than the second method. The second method may result in unnecessary duplication of symbols and some obscurity, but in plants making standard product it is altogether desirable.

In the first method, part of the first sheet of the stores classification would be somewhat as follows:

S—STORES (Purchased Materials)

SA Stationery and office supplies	SP Paper (other than stationery and printed forms)
SB	
SC	SR Rubber and articles made chiefly therefrom
SD Dyestuffs	
SE	SS
SL Liquids	SX Tools and appliances
SM Metals	SY Repair parts for machinery
SN	SZ Fuels

Under this method the further classification of stores results in a narrower definition of each type of material. Thus SMZ might stand for metal fasteners. That being the case, SMZB would be bolts and SMZBH hexagonal bolts. If made of various materials, such as wrought iron, cast steel, cold-drawn steel, etc., each variety might be distinguished by a number, so that SMZB1H might mean a wrought-iron bolt. The size of the bolt would be indicated by dimension numbers placed between two of the symbols (not between the last two), as SNZ⁷2B1H. This shows that the bolt is $\frac{7}{8}$ inch in diameter and 2 inches long.

In this type of stores classification it is frequently desirable to set up, as major divisions, some types of materials which are particularly important in the business. For instance, in a textile plant operating its own dye-house an example would be found in dyestuffs, as indicated above. The nomenclature for stores under this main division might be built up as follows:

SD—DYES

SDA Acid Dyes	SDM Mordants
SDB Basic Dyes	SDN
SDC Coupled Dyes	SDP Naphthol Dyes
SDD Developed Dyes	SDR

SDA—ACID DYES

SDAB	Acid Dyes, Blue	SDAR	Acid Dyes, Red
SDAG	Acid Dyes, Green	SDAV	Acid Dyes, Violet

SDAB—ACID DYES, BLUE

SDA1B	Acid Peacock Blue	SDA3B	Alizarine Sapphire
SDA2B	Alizarine Blue		etc.

In the second method of stores classification the first sheet will have the materials grouped mainly with reference to the products on which they are used. Such classification is particularly valuable in plants manufacturing standard products, or in plants where a large proportion of the stores are intended when purchased, for use on one particular product. To illustrate:

SF	SN	Stores for night latches
SG	SP	Stores for padlocks

By this method the stores which are used exclusively on one of the products are classified by the same general symbol as the product itself, with the prefix S. Using the same illustration as that which was used to develop the worked-materials nomenclature, it is found that the shackle post for a heavy-duty padlock is designated as SPII4B if the piece be purchased rather than manufactured. If the piece be made in the shop and then put in the storeroom, its worked material symbol would be PII4B. This illustrates the most valuable advantage of this method of stores classification. Under it, the symbol for stores and worked materials vary only by the prefix of the letter S, provided that the part is used exclusively on one type of product.

The stores used for a variety of purposes must necessarily be classified by nature, rather than by the use to which they are put. The skeleton nomenclature for such stores would be therefore as follows:

SVA	Miscellaneous stores, not otherwise classified
SVB	Brass and articles made chiefly therefrom
SVC	Cast iron
SVL	Liquids
SVT	Textiles

Mnemonic nomenclature of tools. Tools are classified in much the same manner as stores. The prefix X is usually retained in any accounts dealing with tools, as indicated in the master sheet. This prefix is ordinarily dropped when stamping the symbol on the tool or referring to the tool for shop purposes. For a metal shop, which has most need of an elaborate tool classification, the following is an effective base sheet:

- XA Miscellaneous Tools for special purposes not elsewhere classified.
- XB Abrading Tools—All tools for filing, grinding, polishing, rubbing, scratching, scraping, lapping, etc.
- XC Clamps and Holding Devices—Clamps and holding devices of all kinds including bolts and screws, except J & N.
- XJ Jigs and Fixtures—Holding devices for specific purposes in connection with the product worked upon. Designed for manufacture of duplicate parts of a given product.
- XX Containers—Containers for holding materials, except as classified under C, J, or T.
- XP Paring Tools—All tools which remove material from the surface by means of stationary tools and produce the required size through the operation of the machine, excepting L.

P—PARING TOOLS

PC Parting Tools	PS Square-nose Tools
PR Round-nose Tools	PT Thread Tools

PR—Round-Nose Paring Tools

- PRB Blunt Round-nose Tools
- PRS Sharp Round-nose Tools

PRB—Blunt Round-nose Tools

- PRBL Blunt Round-nose Tools, Left-hand Bent
- PRBR Blunt Round-nose Tools, Right-hand Bent

Mnemonic nomenclature of machinery. Machinery, like tools, usually retains the main classification letter (Y) when its symbol is used to express an account, but drops it when used for shop purposes. Machinery may be classified either by the use to which it is put or by trade name. A portion of the subdivisions, if classification be by use to which machinery is put, might be as follows:

- YB—Abrading Machinery—Removes material from surface by abrasion.
- YE—Energy-transforming Equipment—Changes energy from one form to another without the intervention of a machine, e.g., boilers and transformers.
- YK—Revolving Cutting Machinery—Removes material by a revolving motion, either in the tool or material, e.g., lathes, boring mills.

If the classification be by trade name, which is more common, some subdivisions might be:

- | | |
|-----------------|---|
| YB Boring Mills | YP Presses |
| YG Grinders | YT Tumblers |
| YL Lathes | YV Production centers which do not include machines |

L—LATHES

LA	Automatics	LL	Low-swing Lathes
LE	Engine Lathes	LT	Threading Lathes
LH	Hand-feed Turrent Lathes	etc.	

If there be a number of machines of the same type in the shop, each is designated by placing a number after the machine symbol, as LE7, engine lathe number 7.

Mnemonic nomenclature of buildings. Buildings may be readily classified and symbolized in some such manner as the following:

ZC	Conveying Devices	ZP	Underground Piping and Tunnels
ZE	Building Equipment	ZR	Power-house Structures
ZF	Office Space	ZT	Transmission Lines
ZM	Manufacturing Space		

Summary of mnemonic nomenclature. Although any portion of the mnemonic scheme of nomenclature can be used separately, and although it may be adapted in any desirable way, or used in conjunction with numerical nomenclature, it has been discussed above as a complete system. As such it completely fulfills the objects that were established for standard nomenclature. In the first place, it gives a measure for the definiteness of functions because by it the duties of individuals can be definitely codified, be they executive, clerical, or manual; secondly, it provides a definiteness and correct sequence of operations by the use of the product classification in conjunction with proper routing and despatching methods; thirdly, by means of the stores and product classifications, it provides for locating materials, both in the storeroom and in process, and makes easier the task of keeping a perpetual inventory of these articles because of the elimination of much writing of names that would be necessary if there were no symbols; fourthly, costs are more readily obtained.

From the master sheet of the classification (Fig. 91) it has been seen how these primary elements are provided for and how, by the elaboration of the various groups, every item of expenditure is given a symbol. With the correct use of these symbols, the allocation of costs is made comparatively easy. It is not the purpose here to illustrate this point, because a more detailed knowledge of the functions and operation of the production department is needed to comprehend fully the true relation between classification and costs. Finally, the system serves as an automatic index for the filing of all "inside shop" information. If information about an operation is to be filed, it is filed by the operation symbol. The same is true of machine specifications and records, product information, cost records of products, and all other matters pertaining to shop routine.

It was pointed out that the functions of individuals were classified. Thus information regarding the individual or his functions can be filed by those same symbols which designate the main classes. Stores records are filed by the stores symbols. Time-study data and blue-prints are filed by the symbol of the product to which they apply.

PART V

JOB STUDY

CHAPTER XXI

PRELIMINARY JOB-STUDY CONSIDERATIONS

The need for job studies. Many manufacturers have permitted, and some still permit, line supervisors, such as foremen, with a multitude of duties to perform, to set job standards.

Gradually, industry has turned to methods which have substituted exact knowledge, as gained by job study, for guesswork, and careful analysis for the somewhat intangible standards based wholly on experience. The correlated and classified information gained through job study is now being used as stepping stones to better methods of turning out jobs, the best method if possible.

Lack of knowledge of what should constitute a job and how long it should take is one of the basic causes of labor disputes and industrial unrest. Since neither the employer nor the employee has any real information concerning these phases of the job, or concerning a single job in relation to other jobs, arbitrary standards are frequently set up by both sides which are widely divergent in order that they may be safe for each. An attempt of either side to enforce the basis that it has arbitrarily set up results in dispute, which is usually settled by a compromise not predicated on facts, and satisfactory to neither party. Just as lack of job standards is one of the most frequent fundamental causes of industrial disputes, plants which have carefully set job standards are ordinarily those in which there are the fewest disputes and in which such disputes as do arise are settled most promptly and amicably. There is a basis of exact knowledge on which to settle them, and facts are used in these plants rather than opinions, prejudice, connivance, or force, which have been the more usual bases of settlement.

Only the surface of the limitless possibilities of job study has been scratched by industry. The gold mine has been found and it has tested true, but it has not been extensively worked. Plant after plant has failed to make advances in this, one of the most important phases of modern management. It may almost be said that industry after industry has

failed to take advantage of the opportunities which it offers. Its constructive benefits, which cause improvements in every phase of the business, lie as an unopened book to large portions of the industrial community. Other portions of this community, while sensing the efficacy of the information gathered through job study, have endeavored to utilize it as a weapon of offense rather than as a basis for amicable agreement.

The purposes of job study. The purposes of job study are two, the first of which may be utilized independently, without any thought of the second. These are to improve methods and conditions of work, and to develop a basis for the setting of rates. Methods are improved through a study of the operation and then, from the findings of the study, the equipment furnished workers is changed and the new methods are taught them.

Bettering methods of work. Anyone at all familiar with industry knows that, on most jobs, different operators, if left to themselves, will do their tasks in entirely different lengths of time. Differences of 100 per cent in the time that it takes two operators to do the same task are not at all unusual. In one textile plant, it was found that certain weavers were earning up to \$60 a week on the same tasks on which other workers were only earning \$15, work being on a straight piece-rate basis. Upon inquiry, it was found that the foreman felt that the reason for the discrepancy between such groups of workers was that they were "born that way." It usually will be found, after study, that such operators are utilizing entirely different methods to perform the job. If the two workers be analyzed, it will be found that one has discovered a number of short-cuts, while the other is performing a large number of useless or cumbersome motions. It is thus seen that the first step in job study is to determine the way in which the best worker performs the job, in order that some of these methods may be imparted to the poorer workers. The next step is to endeavor to develop a standard method, which may be an improvement over the best method used up to that time, and which will not only improve all existing methods of working, but will include the utilization of all possible standard equipment for the job and which will determine and, if possible, eliminate, the causes of fatigue incident to the job.

Motion study. Motion study is the simplest form of job study, and always forms the preliminary portion of a job study, even if a more elaborate study, such as a time study, is contemplated.

The simple motion study of a job in its general elements may reveal many losses and useless motions without any consideration of the time element. It is not necessary to hold a watch in one's hand to know that a worker who must walk a dozen feet to secure material for his machine or to deposit the finished product of his operation can have his work arranged more effectively. Sitting down beside the workman over a period of several hours and following what he does in a general rough way

will yield valuable information concerning sources of losses of this nature. Then in the study of the specific details of the job as the workman works upon it, the study of the "swing" or rhythm which the workman gets into his body on repetitive work can be made without regard to the time element. General motion study is likely to yield valuable information for the betterment of standards of equipment, and the elimination of useless motions is oftentimes one of the best ways of reducing fatigue. So all the aims of job study may be achieved without consideration of the time element, although if it is desired to refine these results, time study is usually utilized.

Interest in job study had been gradually increasing for a number of years, when certain experiments of Frank B. Gilbreth, in bricklaying methods, set forth in a small book called "Motion Study,"¹ crystallized interest in this subject. This was at about the time of the general increase in interest in the management movement, during 1911. Gilbreth's attention had been forcibly drawn to wasteful operation methods in this trade through his then connection with the contracting business. He had found, for instance, that bricks were dumped in a pile somewhere near the bricklayer by his unskilled assistant, and that the bricklayer would take two or three steps over to the pile of bricks, pick up a brick, walk back to the point in the wall where he was going to put it into position, give it several twirls, so that the right side for laying would be upward, and then proceed to put it into place. He also found that there were a large number of similar waste motions in connection with the placing of the mortar. From these observations he developed certain standard equipment, such as a packet for holding the bricks at a proper level and with the right side already up, and a non-stooping scaffold, which changed in height as the wall was built up. He then developed the best methods of utilizing this equipment, based on observation.

As the methods used by bricklayers on nearly every construction job are observed to-day, it will be quickly noticed that the studies of Gilbreth and others have not made the impression on this ancient art that might have been expected. This condition is sometimes due to the contractors, but in general it is caused by the attitude of the bricklaying unions to the studies of Gilbreth. As in the case of other labor organizations, they have not been favorable to the developments brought about by job studies, and they have been strong enough to resist successfully the introduction of much of the new method. A full discussion of the reasons behind this attitude will be included later.

One of the next fields that was investigated, after Gilbreth directed attention to the wastes involved in ordinary bricklaying practice, was office work. In the handling of outgoing mail it was immediately seen that there were vast opportunities for economies in an improvement of

¹ D. Van Nostrand Co., New York.

the methods generally used in large offices. If several thousand letters are being mailed a day, as is the case in many industries, the saving of only one motion per letter mailed would result in an enormous net gain. For instance, in one office the girls folding and sealing the letters formerly were permitted to arrange the work to suit themselves. A short observation of their work showed that there was much room for improvement. Experiments were made to determine in just what order each movement should be made to fold the letter, pick up its inclosure, pick up the envelope, and insert the letter and its inclosure in the envelope. First attempts were crude, but immediately doubled the output of the girl. Further study resulted in improvements which not only eliminated motions, but shortened the distance through which the hands had to move in those that remained. The final result was an arrangement of pieces and a sequence of motions, by which each hand, at the completion of one motion, was in a position to begin the next immediately. The final motion, that of throwing the filled envelope on the pile, was eliminated entirely by having a large basket on the floor, directly under the point where the letter was inserted in the envelope. The girl simply let go of the envelope, and it fell into the basket, gravity doing the work formerly done by the girl. The output under the new conditions was about four times that obtained when the girls were allowed to do their work their own way.

Effects of taking motion studies. There are three possible changes which come through the taking of motion studies. First, whole methods of performing operations may be changed and newer and more effective ones found. Second, moderate changes in method and in equipment may be devised. Third, data are always secured from which a series of job specifications may be developed.

Motion study and the development of standard equipment are inseparately linked. Frequently, soon after the start of a study, it becomes apparent that the worker can do no better with the equipment at hand, because he is forced by it through a series of false motions. Motion study may lead to such standardization of equipment on an operation that no further steps are needed in the instruction of workers in the performance of their jobs than instruction in proper use of this equipment. In changing the methods used on the operation, changes are always made in the direction of straighter, shorter, quicker motions of a kind which tend to swing into the following motion, and which become automatic wherever possible. Particular information for job specifications is secured concerning the dexterity, strength, and temperament required of the worker, as well as any unusual requirements which are peculiar to the job.

Meaning of time study. By time study is meant an accurate analysis of the time necessary to perform a task or some part thereof. It involves all the features of close observation that are found in motion study, and

in addition there is included the time element. In modern industry, for purposes of job study all work may be placed under two general headings: (1) work done by machines and (2) work done by workmen. Motion study generally includes only a study of the work done by workmen, whereas time study includes a detailed analysis of both "machine time," or the time taken by the machine in doing its share of the work, and "handling time," or the time taken by the workman. Handling time will usually be found to be of three general classes, (1) the handling of tools used by the workman in connection with the job, (2) the handling of the machine by the workman, and (3) the handling of the material that is being worked upon. Time study implies an intense analysis of all these phases of work.

Purposes of taking time studies. The purposes of making such an intense analysis of work are in some respects not dissimilar from the reasons behind the making of any job studies. Improvement of methods and conditions are at times the only reasons for the making of time studies. Indeed motion studies are frequently but the first step in the taking of time studies, and pure motion studies are not so frequently used as time studies, since with but a slight additional cost the additional valuable data securable through time studies may be made available. The addition of the time element to the study makes it possible to secure information concerning the amount of work which may be accomplished within a given time. This information gives an adequate basis for establishing the remuneration to be given a worker for his performance. Thus, the results of time studies are used as the basis of "rate-setting," or the determination of wage rates. This is the second broad purpose for which time studies are used and the one which will be in the background of most of what is here said concerning time studies. However, time studies cannot be used for rate-setting without being used at the same time to improve methods or conditions.

Time study provides data which are invaluable in setting rates that are relatively fair as compared one to another. It cannot be expected to set rates that are inherently fair from a cost-of-living or other similar standard. That is beyond its province. It does clearly indicate fair relative rates to be paid on the several jobs studied. It bases results upon facts rather than upon opinions, bargains, or past records.

Rates, if not based on time studies, are likely to be based on past performances. Standard time and, hence, rates, based on past performances, are likely to be unfair. In all factories are to be found poor workmen and good workmen. A good workman on job A takes an interest in his work and in the mastering of his job. A poor workman on job B is probably indifferent to his work, or it may be that he has never been properly instructed as to the right way of working on the job. If the rec-

ords of poor workmen and good workmen are thrown together, throughout a shop, as "past performance," the resulting basis of rate-setting is likely to be unfair. The poor workman, by learning his job or merely by applying himself, may be able, under such conditions, to double his pay, whereas the good workman, if the job is one where he has always set a high standard, will get but a slight wage increase, if any. In other words, the poor workman will be rewarded for his indifference of the past, and the good workman will be penalized for his past attention to duty. Other difficulties in setting rates on the basis of past performance are due to the fact that past records are frequently extremely unreliable. Jobs of the past frequently were made up of different elements than jobs of the present. Conditions under which jobs were performed often have been modified by forgotten changes in equipment which are not taken into consideration as the new rate is set. Frequently, since the past records are so unreliable, it is necessary to resort to bargaining concerning what past performance was. Nothing can be more destructive of the wage fabric of any plant.

Steps in taking time studies. To secure accurate knowledge of the time that is necessary to perform a certain job is by no means in itself a simple task, and the taking of the time is but one portion of the whole task of taking a time study. Time studies, to be of any value, must be "elementary time studies." That is, the time must not be taken for the job as a whole, but for the various elements of the job, and then the correct time for the complete job determined upon after making an analysis of the times necessary to do the various elements. In the job of operating any machine there will be found a long series of elements, ranging from those involved in starting the machine and placing material in it, through those involved in turning certain controls during the operation of the machine to those involved in removing the work from the machine. The taking of the times, when the job is split into such a large number of small elements, is a rather skilled task.

In taking time studies there is entailed (after standardization work has been completed) first, a careful survey of the task to be done, with a view to improvements in method of the kind referred to in the discussion of motion study. These improvements are then made, or are made in conjunction with the second step, namely, the division of the task into its elements. The third step is the "taking of the times," or observation and record of the time consumed in each of the elements of the job; the fourth, a study by analysis of the records obtained; and the fifth, the fixing of the proper operation time on the basis of these records.

The fourth and fifth steps involve considerable study, in determining the correct way to utilize the information which has been collected. In recording times for elementary operations it is usually found that there have been some abnormal readings, and these must be eliminated; allow-

ances must be made for delays which may have occurred, or which may occur in the future, and these delays must be considered in the light of their being avoidable or unavoidable. There must usually also be some allowance made for fatigue on the part of the operator. Frequently, on the basis of the data, the whole job is rearranged and restudied.

The job-study observer. The first requisite in job study is that the observer be competent. This is so outstandingly true that it would be ridiculous to mention, were it not that incompetent managers frequently use incompetent time-study observers, and otherwise competent managers have frequently seemed to feel that anyone, equipped with a stop-watch, could secure the necessary information. It is for this probably more than any other reason that job study fell into disrepute among many portions of the industrial community. The observer must be of an analytical turn of mind, able to detect small variations in the process from time to time. He must, however, have enough knowledge of the machine and process to be able to perceive and try out slight mechanical changes which may be called to his attention during his studies.

Besides these technical qualifications, a job-study observer must be able to win the confidence of the men with whom he is working. This means he must himself have confidence in the workers and gain their confidence, as well as gaining the confidence of the superintendent and the foremen. This implies that the observer must have an outstanding personality which will cause the workers to want to aid him in his experiments, rather than resist his efforts to change their job. If the observer creates the impression that the worker himself is making all the suggestions it is probable that his full co-operation will be secured. In devising a standard method to perform a job, many possibilities will have to be investigated, and the worker's co-operation is essential, particularly if he has a fund of knowledge based on past experience with the task.

There is no intention to minimize the necessity of technical qualifications of time-study observers, because the more the observer knows of the operation, the better able he will be to suggest alternative methods. On the other hand, if he has gained the confidence of the whole department in which he is working, he has performed a large portion of his task. Some firms have tried to take time studies with the observer nonchalantly observing the worker with a stop-watch in his pocket, or probably two or three of them in different pockets. Other concerns have utilized balconies in the shops to take time studies without the worker's knowledge, and then have wondered why the workmen made objection to approving them as a wage basis when suddenly apprised of the "results." Confidence, as the prime element of success in time-study work, cannot be over-emphasized.

Confidence is necessary for several reasons. (1) As in any manage-

ment step, full co-operation of everyone is needed for the best results. (2) Secrecy is impossible even should it otherwise be desirable. The workmen will hear rumors, which will be worse than the facts, whatever they may be, and these rumors will be confirmed when their rates are changed based on the observations that they knew only rumor of. (3) In order that the time study may be of maximum value, it is necessary that shop information, which has been collected by the foreman and workmen over a period of years, shall be at the disposal of the time-study men.

The operator to be studied. Shall the operator be the best man who is available, should he be a first-class man, should he be an average workman, or should he be picked indiscriminately from the shop? It will be noted that this question may have to be answered differently in the case of time study from the way that it is answered in the case of motion study. In the latter case, the study is being made purely from the standpoint of method, whereas with time study the study is also usually to be used for the purpose of setting rates. Time-study men generally incline to the belief that it is the skilled, first-class worker who should be studied. This means that the worker will be of better than average ability, and will be as good on quality as he is on quantity. This does not mean that the study will be made on a man who is working at a terrific rate of speed, for such a man probably is turning out no more production than the man who, more skilled, is taking things easier.

The skilled man is selected, rather than the average man, because allowances will be made in the computation of times which will be fair to the average man, and the skilled man is better for observation purposes. His motions are uniform, he works steadily, he is apt to use the best methods and adapt himself more readily to new ones. The erratic work of unskilled employees would throw all sorts of variables into the calculations, which would merely have to be ruled out as the computations were made. The experienced time-study observer, acquainted with the character of the work, soon learns when a skilled operator is doing his best. He would have more difficulty in finding this out in the case of an unskilled operator. The observer, with the skilled man, is able to get him to better his production if need be, or, on the other hand, to recognize unusual ability or excessively rapid movements on the part of the operator which could not be maintained without physical exhaustion. Such cases are properly discounted by him, for the desired task time is one that can be used by workers following instructions and working at a reasonable pace—a pace that can be kept up from day to day without undue exertion. Another reason for the selection of the skilled man is that in setting performance standards, as in setting any other standards, the best known at the time for the given conditions should be selected as the standard.

On work in which large numbers of workers are engaged, and which is to

last for some time, more than one operator should be time-studied in order that the resultant rates may represent standard performance without question.

The conditions of the observation will have to be varied somewhat in the case of "group work," that is, work in which the individual task is performed by more than one employee. In such work as assembling, the speed of the group is limited largely by the speed of the slowest member. Therefore, in such cases, it will be necessary to consider carefully the personnel of the group to see whether or not it is entirely composed of skilled employees, and, if not, whether such a group can be brought together. There are two classes of group work, and the necessary skill of all members of the group will vary with the class into which the particular work falls. These classes are, (1) where the main part of the operation is performed by one employee, and he is merely assisted by other employees, and (2) where several employees work together, each doing his portion of the job in proper sequence.

An illustration of the first type of group work is to be found in the operation of laying cloth in a clothing factory. Although the operation is comparatively simple, it demands a certain knowledge of the tailoring trade and the peculiarities of cloth, to handle each type properly. A cloth which has a very smooth finish may be easily disarranged in pulling one layer over the next, while another which has a heavy nap may tend to stick and must be handled in an entirely different manner. One employee cannot do the work alone because of the width of the cloth, which requires that he have an assistant working on the opposite side of the table. The assistant, of course, must learn how to handle the cloth, but he does not need as much detailed knowledge, and hence will not need to be as skilled an employee as the one in charge of the operation. As an example of the second type of group operation may be taken any case of continuous assembly, where the speed of one worker is limited by the speed of another, and yet all of them are doing work of approximately equal importance.

Dangers to be guarded against in taking job studies. Though the possibilities for good of job study, properly used, are almost unlimited, when incorrectly used its possibilities for evil are the same. Job-study methods must be guarded as would be high-voltage electric wires. A danger to be guarded against is an approach to a workman based on superiority rather than on science. There is a great tendency, particularly if the observer be inexperienced, to tell a workman who has the experience of years behind him that he is all wrong. Every possible safeguard must be developed to prevent such interpretation of the attitude of the observer. The worker may have been all wrong in such a case, but so was the observer. Another danger to be guarded against is the taking of time studies when the

conditions are not standard. Not only will all the work done be useless under such conditions, but the studies themselves will fall into disrepute. This is particularly true if the workmen knew of the loopholes in the standards being set at the time the studies were taken. They then will be in an excellent position to hide their smiles and criticize unmercifully. Time spent on the development of preliminary standards of material and equipment will pay profits much more promptly than twice as much time spent on standard times for unstandardized jobs. This "standard" time will be worthless, being based on variables. A third danger is to spend time in making "stunt" time studies. There is always a tendency to spend effort in reducing the time of performance on operations which are palpably poorly carried on. In such cases statistics of percentages of time reduction will be very interesting, but if the operation be an unimportant one, as it may very probably be if such huge reductions in performance time are possible, the profit from the study will be small. A series of such studies may cost more than the resultant profits, and a whole job-study program thus fall into disrepute. The neck-of-the-bottle operations, the most important in any plant, should be studied first. Even small results achieved there will bring large profits with them, without question. It may take longer to get results, but if the continuation of a job-study program is based on quick results, the program should never be undertaken.

CHAPTER XXII

TAKING TIME AND MOTION STUDIES

Time-study equipment. The equipment for taking time studies is essentially simple, though some improvements which are now being tried out will be described. The ordinary equipment consists of a decimal stop-watch, an observation sheet on which the watch readings are recorded as the study progresses, and a board for holding the watch and observation sheet. Many different forms of observation sheets have been devised. The attached sheet (Fig. 93), used by the Corona Typewriter Company, of Groton, N. Y., will be used as the basis for this discussion of making time studies. It is selected because of its completeness and the care which that company observes in making and utilizing job studies. In any event, the observation sheet must have space for a full description of the operation and conditions under which it was taken, with the latter illustrated, if practicable; space for entering the times of the various elements as they are observed; and a series of columns concerning the time of each element and the proper time for the whole operation.

The usual stop-watch used in time-study work is a non-continuous-movement watch; that is, the movement of the watch runs only when the large hand is in motion. The large hand may be started and stopped by pressing a slide on the side. This arrangement allows the watch to be started and stopped at will, without throwing the hand back to zero. Pressure on the top of the stem throws the hand back to zero so that the observer can commence the record of a new cycle at zero if he should so desire. The dial of the watch is marked off into tenths and hundredths of a minute, instead of seconds and fractions of a second. This simplifies recording and computing of times. This watch fits into a pocket near the top of the board carrying the observation sheet, and the board is of such a size as to be conveniently carried on the observer's left arm, so that the work, watch, and observation sheet may all be in a straight line with the observer's eye. The use of this equipment will be assumed throughout the following pages.

There are various special developments of the stop-watch methods of taking time studies. Some observers utilize as many as four different watches in taking one study, having specially rigged levers which throw them off or on as desired. By utilizing several watches these men feel

that they secure more accurate results, especially on short elements, because they can read the watch at their leisure, instead of taking a hurried reading in between elements of an operation. Frank B. Gilbreth also utilized the motion-picture machine in taking time studies, by placing a special clock in the field of vision and recording thereby the times for the various operation elements. He built up very satisfactory arguments for the utilization of this method where the elements are short and the work is on a standard product.

The preliminary study. The work of the job-study observer in what may be termed "the preliminary study" is, economically, in many ways more important than the actual recording of times themselves. From a wage-setting standpoint it is of paramount importance also, because it is frequently the work done here that determines the effectiveness of the final study. The "preliminary study" includes all of the work prior to recording the actual elementary times which are observed. It includes the motion study that is taken in order that the work may be done in the most effectual way. It also includes some preliminary time studies taken to check the effectiveness of the motion studies, and to determine and record the elements of the task to be timed.

Having determined upon the operator who will be timed, the observer should spend some time acquainting himself with the work and all conditions which are affecting it, or might affect it. He should observe the conditions under which the raw material is furnished the operator and the facilities which the operator has of disposing of the finished product. He should familiarize himself with the quality of the work demanded and the degree of accuracy required. He should see that the necessary equipment for the operator effectively to perform his task is provided and at hand, and, if the operation is a machine one, he should see that there is a sufficient supply of power to drive the machinery to best advantage. Abnormal conditions should be remedied during this preliminary study. Full information should be secured concerning the standards of accomplishment on the job in the past, in order that comparative achievement records may be available after the job has been studied, changed, and timed.

Determining upon the elements. Preliminary job studies, in determining upon the elements, must necessarily include a detailed study of the methods of job performance. It is in such studies that analysis is made of the motions that the worker takes in doing the work, and it is through the elimination of useless motions and the provision of standard equipment that much of the savings incident to job study are made. In order satisfactorily to carry on a motion study, and in order to secure the basis for an accurate time study, it is important that the job be broken down into its elements. It is only by a study of the elements that it is possible to determine whether the work is being done in the best and cheapest way.

SET

OPERATOR
THIS JOB - 3 YRS. DRILLING
GRADE AND RAPID
DRIVER EXCELLENT

PURPOSE OF THIS STUDY--

FOR SETTING STANDARD TIME AND RATE

YES.

FOR PRELIMINARY SURVEY FOR BETTERING CONDITIONS

FOR TEST OF OPERATORS PRODUCING ABILITY

HUNDRETHS

	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	AVERAGE TIME	MINIMUM TIME	TIME SHOULD TAKE
2	09	09	10	09	09	10	08	09	10	10	10	11	10	11	09	09	10	11	10	11	10	09			
3	09	09	10	09	09	10	08	09	10	10	10	11	10	11	09	09	10	11	10	11	10	09			
4	46	45	46	44	46	49	47	46	46	44	44	44	45	44	46	46	45	42	40	41	41	44			
5	07	5	58	55	57	58	59	57	56	54	54	53	53	53	57	57	55	51	50	50	51	55			
6	99	98	101	98	100	98	101	99	98	95	96	97	97	96	100	101	98	95	95	95	96	99			
7	53	53	55	54	54	55	54	53	52	51	52	53	52	52	51	53	53	55	53	54	54	53			
8	11	14	12	15	14	16	14	17	16	14	12	13	14	13	14	17	19	15	11	11	11	14			
9	15	14	15	16	16	16	16	17	16	17	16	16	17	17	17	18	17	16	16	16	15	15			
10	20	18	21	20	23	21	23	22	20	17	18	20	21	19	25	26	22	17	17	18	16	20			
11	06	06	06	06	07	07	06	06	06	05	06	07	07	06	08	07	07	06	06	07	06	06			
12	27	25	29	28	30	29	31	30	27	25	26	27	27	25	32	32	29	24	24	25	24	27			
13	07	07	08	08	07	08	08	08	07	08	08	07	06	06	07	06	07	07	07	07	08	07			
14																									
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29	11	10	11	10	10	10	09	08	10	09	09	10	09	09	12	11	11	10	09	10	11	10			
30	11	10	11	10	10	10	09	08	10	09	09	10	09	09	12	11	11	10	09	10	11	10	1022	08	10
31	44	45	44	44	44	44	46	46	47	48	46	46	46	45	46	40	42	44	41	42	42	44			
32	33	35	33	34	34	36	37	39	39	37	37	36	36	37	32	31	39	31	33	35	33	36	3382	30	33
33	97	98	99	98	98	100	100	100	97	97	98	99	97	98	94	97	97	94	97	98	98	100			
34	53	58	55	54	54	54	54	53	54	51	52	53	52	52	54	53	53	53	55	54	54	54	5312	51	53
35	17	12	12	13	14	14	16	16	17	13	14	14	15	14	15	11	15	14	10	13	15	15			
36	15	14	14	16	16	16	16	16	16	17	16	16	17	17	17	18	17	16	16	16	15	15	1582	14	16
37	17	20	19	20	21	23	23	25	19	19	19	20	20	20	23	21	27	27	21	20	21				
38	05	08	06	06	07	07	07	08	06	05	05	05	06	05	05	08	07	07	06	06	07	06	062	05	06
39	18	19	19	20	20	20	20	20	20	21	21	21	21	21	24	20	29	29	22	27	26	23			
40	08	09	10	08	08	09	07	07	07	08	08	08	07	09	08	07	08	07	07	06	06	08	073	05	07

This is approximately 7% of the
total time taken during study

TOTAL AVERAGE

1244.13 12.5

ation is. Observer must exercise extreme care in making studies for
ers and, (including tools, in sufficient quantities) and that the proper
thoroughly man, moving at his best normal speed. Observer will

H. V. Williams
OBSERVER

DATE

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An element of an operation may be described as a single continuous and distinct motion of a worker or a machine. Thus, in driving a screw, an element consists of placing the screw-driver in position, and another the continuous twisting of the screw-driver while driving the screw. A more complex operation is necessarily made up of a correspondingly greater number of elements, but each of them must be continuous and distinct. For motion study, and the bettering of methods in time study, it is important that each separate element, however small, be analyzed. For the setting of rates, after the method has been established, it is usually desirable to combine several successive short elements, in order that the watch may be read more readily during the progress of the study. It is extremely unwise to try to observe and record elements which follow each other in successions of only a few hundredths of a minute, since an error in the reading of the time on the stop-watch may be as great or greater than the elapsed time for the element in question.

In time studies for rate setting, the extent of separation of the elements is determined by the character of the operation and the length of the elements. For instance, if the product be standard, not varying from day to day, and is made by repeating the same operation or set of operations, it probably will be wise to study the work from the standpoint of complete jobs, possibly lumping the minor elements together. Such time studies may be termed "operation time studies." The attached illustration from the Corona plant is an example of such studies. It will be noted that each suboperation in reality involves a combination of elements. This is the most common type of studies. If the product varies considerably, and is made by a series of operations, the elements of which may quite conceivably also be found in other operations on the same or similar products, it will be found extremely undesirable to lump any elements, for the time for each separate element may be desired in order that they may be regrouped to ascertain time for the other operations. Thus, by taking a series of time studies on a number of more or less fundamental operations and elements in a shop, it may be possible to arrange and combine data in such a manner that the proper time of performance may be secured for practically every job that the shop may perform, without the taking of new studies. Such time studies may be called "fundamental element time studies," and in these the time for each separate element is carefully secured.

After the elements have been determined upon they are noted in the space provided for them on the observation sheet. In the accompanying example it will be found that there have been six elements studied:

1. Pick up, locate, and lock.
2. Drill three No. 40 holes.
3. Drill five No. 48 holes.
4. Drill two No. 9 holes.
5. Unlock and remove.
6. Clean jig.

a view to its particular improvement, this method is wasteful of the observer's time. It does not provide for the securing of information concerning delays and their causes. Furthermore, elements dovetail into each other as the work is performed, and time studies, to be just, should time the worker under actual working conditions. Timing one element at a time is not making the study under actual conditions in every respect.

The cycle method is utilized for the purpose of taking the times of very short elements. The use of this method also necessitates the taking of continuous times. The observer takes the unit times of the elements in as many cycles as there are elements, each cycle including one element less than the total number. The time for each of the elements may be found by working out the equations given below. The sum of all the cycles divided by the number of cycles less one gives the operation time. By subtracting the total time of the duration of any one cycle from the operation time, the value of the element omitted is found each time. The following is an illustration involving four elements:

Cycle 1	Elements	$a + b + c + d = 0.08$
Cycle 2		$b + c + d = 0.07$
Cycle 3		$a + c + d = 0.10$
Cycle 4		$a + b + d = 0.08$
Sum		$3a + 3b + 3c + 3d = 0.33$
Operation time		$a + b + c + d = 0.11$
Operation time		$a + b + c + d = 0.11$
Subtract Cycle 1		$a + b + c = 0.08$
Time of element		$d = 0.03$
Operation time		$a + b + c + d = 0.11$
Subtract Cycle 2		$+ b + c + d = 0.07$
Time of element		$a = 0.04$
Operation time		$a + b + c + d = 0.11$
Subtract Cycle 3		$a + c + d = 0.10$
Time of element		$b = 0.01$
Operation time		$a + b + c + d = 0.11$
Subtract Cycle 4		$a + b + d = 0.08$
Time of element		$c = 0.03$
Therefore:		$a = 0.04$
		$b = 0.01$
		$c = 0.03$
		$d = 0.03$

CHAPTER XXIII

SETTING STANDARD PERFORMANCE

Ascertaining selected operation time. After the time for individual elements has been secured from the observation sheets, the proper time for performing each element and the whole operation may be determined. The first step is to ascertain selected operation time. It will be assumed that the method of taking times illustrated by the Corona observation sheet has been used. Several methods of working up the time-study results will be described. They may be termed the "average" method, the "minimum" method, the "modal" method, and the "good time" method. They will each be described; but prior to taking them up in detail, there will be pointed out certain features which are common to them all.

The first step in any method is to throw out the "abnormal" times. These are times recorded for individual elements that are clearly in error when compared to the other times recorded. The error may be due to one of the following causes: (1) Some delay which will seldom occur or some variation in the way that the element was performed which will seldom be repeated. (2) the wandering of the worker's attention, for instance, talking with a fellow-workman. A certain degree of lack of attention to a job is not only likely to occur, but is desirable, if undue strain is to be lifted from the workers. Such time as is necessary for this, however, should not be included in operation time, but added in the form of an allowance, after operation time has been determined. Other allowances must be added in like manner. (3) Some mistake on the part of the observer in reading the watch, which can generally be noted by the fact that the time of either the preceding or succeeding element is likely to be abnormal, whereas the sum of the two abnormal times will be approximately the sum of the average times of the two elements.

Striking out abnormal values, either higher or lower than the general average, calls for fine judgment on the part of the observer. Nevertheless, it may be assumed that any times which vary more than 25 or 30 per cent from the average may be stricken out of the calculations. On short elements it is not always practical to adhere to the percentage basis. Thus, no observations have been stricken out on the attached example. The only ones which might be excluded under the suggestion just given are the readings, which occur once each, of 0.05 and 0.10 on the last ele-

ment. Inasmuch as these in no way interfere with the final result, since they are both but slightly outside the limit and balance each other, they may be retained. There are a few kinds of work in which the abnormal values should be figured in, when working up the study. These include construction work and repair work.

According to the "average" method, which is the simplest, those individual element times which remain after the abnormal readings have been eliminated are averaged. If the average method were used, these average times would also be the selected times and would be so indicated in the last column of the observation sheet. The selected operation time under this method is found by adding up the average time of the separate elements. The objection to this method is that it may make the individual element times and hence the final operation time too high, because it includes all observations other than those which were abnormal. In adding allowances, these higher times are automatically taken care of, and this method has the effect of giving too much weight to the higher times.

The "minimum" method provides for taking the absolute minimum for each element, namely, that time which, in all the observations, was the fastest for any one element, and then adding these together to get the selected operation time. In this method, therefore, the minimum time and the selected time are the same. This has the effect of materially reducing the selected time below that which would be found under the "average" method. For instance, in the illustration given, the selected time for the complete operation cycle of six elements would, under the "average" method, be 1.2648 minutes, while under the "minimum" method it would be 1.13 minutes. It is generally held that this method is too severe and not fair to the workman, even with the addition of allowances, since to choose the minimum time, which might only have occurred once out of twenty observations, usually means taking a time that is just over the 25 per cent borderline, and is not quite thrown out.

The "modal" method is one of the two most frequently used. It consists of taking the most frequently recurring element time in the observations as the time for that element. Thus, in element six in the illustration, the time 0.07 recurs 47 times, whereas the times which recur next most frequently are 0.08, 34 times and 0.06, 13 times. Therefore, 0.07 would be taken as the selected time for that element. The selected operation time is secured by adding together the various element times, thus secured. If two elements recur with equal frequency, usually the average of these elements is taken. Under this method, the selected times for the elements in the illustration would be as follows:

1—0.10 (40 times)	4—0.16 (40 times)
2—0.33 (30 times)	5—0.06 (43 times)
3—0.54 (29 times)	6—0.07 (47 times)

The selected operation time in this case would, therefore, be 1.26 minutes, which is just less than the average time. Usually the modal time is more pronouncedly less than the average time and is, of course, always greater than the time secured by the "minimum" method. The modal method eliminates the objections to the two previous methods, and at the same time gives a selected time which can be achieved, as is evidenced by the fact that it is composed of the elementary times which were themselves most frequently achieved.

The "good time" method is merely the modal method applied with some degree of flexibility. In the "good time" method a time which recurs with reasonable frequency is selected rather than the one which happens to occur most frequently. The fact that the time recurs a number of times indicates that it can be made, and the justice of this method lies entirely in the interpretation of "reasonable." A time to be reasonable certainly should appear in from 10 to 15 per cent of the observations. The time selected might presumably be the modal time, but it is likely to be somewhat lower. In the illustration, but one element would be changed, but this is somewhat unusual. That element would be number three, where 0.52 occurred 25 times, 0.53 occurred 28 times, and 0.54 occurred 29 times. 0.53 has been selected, thus making the selected time for the whole operation 1.25 minutes, as indicated.

Time-study allowances. As previously indicated, there must be added to the ascertained selected operation time certain allowances, through which provision is made that the task time set for a job shall be capable of accomplishment over long periods. These allowances include: (1) Allowance for the preparation time of the machine. It will be noted that the machine will only have to be prepared to do a job once, although the job may be repeated many times in succession. This is therefore in the form of an allowance rather than an element of the operation. (2) Allowance for necessary machine delay. (3) Allowance for fatigue of the operator. (4) Allowance for personal needs of the operator, oiling machine, etc. The preparation allowances may be sometimes determined with as much exactness as the selected time. On the other hand, the provision of proper allowance for machine delay, fatigue, and personal needs must involve as an element the judgment of the person who computes the allowance. Therefore, if care be not utilized in the making of the allowances, any amount of care utilized in timing of the operation or selecting the unit times may be negated.

The taking of time studies for the purpose of setting rates furnishes a basis on which definite tasks may be set. The selected operation time is the time in which the operation could be performed by a highly skilled worker under ideal conditions.

Task time. The selected operation time is a time that can be "made,"

but not one that is usually made. This manifestly would be an unfair basis for the setting of rates. It is desired to fix a time which will be within the ability of any worker, properly instructed. This time is secured by adding the allowances to the selected operation time, and is known as "task time."

The measure of the fairness of the task which has been set is the ability of the average worker to make it, and the ability of the extra-skilled worker, working under good conditions, to better it. The purpose of time study is to set a time which may cause the worker to accomplish the maximum amount of work with the minimum amount of fatigue, as only with such a task basis can maximum production be maintained day after day. The selected operation time is not such a basis, but would only be a basis for setting a task for a highly skilled worker, working under ideal conditions.

The relationship of the allowances to task time is important. One of the chief criticisms leveled at time study has been that it sets a rate which only the best workers can hope to achieve. The addition of proper allowances changes the selected operation time to a task time which the average worker should better consistently if properly trained, while the better worker will be able to approach the selected operation time consistently. Indeed, some newer wage systems depend upon the fact that task time can be bettered consistently.

Preparation-time allowance. The first allowance which may be made is for preparation time. In any type of work which is not purely a manual job there is involved some preparation of the machine to receive the work that is to be done. The "set-up" of the machine from the last job must be changed. The importance of this, the length of time that it takes, and the frequency with which it must be carried on, differ from job to job and from industry to industry. Preparation time may not always be treated as an allowance. The preparation of the machine may in some cases be regarded as a separate operation, or it may be wisest to regard it as an element of the operation to be performed.

Thus, in a textile mill the preparation of a loom to run a particular style of fabric is a job which may have to be performed only at relatively long intervals. The job has to be performed at most only when a warp has run out and a new warp must be placed in the loom. Since warps are frequently over 1000 yards long, this task may only have to be performed every two or three weeks, and then, when it is performed, it may take a day or the greater part thereof. When the preparation of the machine occurs so seldom as this, and is such a long task when it does occur, it is wise to regard it as a separate operation, rather than to endeavor to make an allowance for preparation time.

In a paper mill, in the beating operation, where the fibers of the pulp

are put into such condition that they will interweave with each other and "felt" on the moving wire of the Fourdrinier machine, the knives of the beating engine must be set differently for different grades of product. Thus the beating engine must be prepared to receive each batch of pulp, provided that different grades of pulp are worked in the same beater. But the beating operation takes only a few hours, as contrasted to the weaving operation just spoken of, and the preparation of the beater takes only a comparatively short time, when contrasted to the time taken by the operation itself. Inasmuch as the preparation must be taken care of on each operation, it would be unwise to make a preparation allowance, and on the other hand it would be incorrect to treat the preparation as a separate operation. In such cases, therefore, by far the best plan is to treat the preparation of the machine as the first element in the operation being studied.

In by far the largest number of operations, the machine is "set-up" once and then the operation is performed several or a number of times in succession prior to the resetting of the machine. It is in such cases that a preparation allowance is necessary. Illustrations of such jobs are to be found in great number in many industries, for instance, in shoe-manufacturing and in any work requiring the use of machine tools. The "pulling over" machine in a shoe factory must be reset for each type of shoe being worked upon. But many dozen shoes are worked on prior to the resetting of the machine. If the operation being studied is the pulling-over of a shoe, it will be seen that the preparation time of the machine must be figured in the necessary time for the performance of the operation, but that it may be figured in terms of an allowance. There should be determined, as in the case of the loom, the length of time it takes to set up the machine, as though it were a separate operation. This amount may then be divided by the number of shoes being made in a given case, and the result may be added to the selected operation time taken to work one shoe, so that each shoe may bear its proper part of the time that it takes to set up the machine to work on the whole lot. For instance, if the set-up time is found to be 48 minutes, and there are 20 dozen shoes being run through, the preparation allowance would be 0.2 minute per shoe. If 40 dozen shoes were to be run through before the machine were reset, the preparation allowance would be 0.1 minute per shoe.

Allowance for personal needs. The allowance for the personal needs of the workman is usually constructed so as to take care also of the regular oiling and care of the machine. This allowance is sometimes known as the "shop constant" because it is usually the same for all operations in the shop. It is ordinarily based on a percentage between 2 and 3 per cent of the selected operation time.

Delay allowances. Delay allowances include allowances for the

fatigue of the operator caused by those portions of the operation which are manual in nature, and machine delay allowances for delays due to difficulties with machines or equipment, which may be outside the control of the operator. It is in the making of the delay allowances that the most care is needed, because these may be so large that unless they are carefully set, all the previous care taken in making and working up the study may be wasted. Why carefully record element times to 0.01 of a minute, and then add a delay allowance of "between 20 and 50 per cent at the discretion of the observer, based on his opinion as he took the study"? Yet many time studies have been worked up on that basis. It is one of the commonest practices connected with time study. It is also one of the chief causes of criticism of time-study work, as practiced. Much laughter has been leveled at the thought of being accurate to hundredths of a minute and then arbitrarily adding 50 per cent to the resulting calculations.

Fatigue allowances. In setting the fatigue allowance there are a number of factors to be considered. The first of these is the working conditions. If these are excellent, that is, if the shop is cleanly, well lighted, and well ventilated, they may be disregarded. If these conditions are not right and cannot be immediately made right, allowance must be made. The next factor is the length of the cycle of the operation. In general, the shorter the cycle, the greater the necessary fatigue allowance. The amount of physical exertion required must also be considered. If a job requires much physical exertion the influence of the fatigue factor is large. However, on such jobs, the original study should extend over a large portion of a day, in order that the fatigue factor may influence directly the selected operation time. The presence or absence of stated rest periods should also be considered.

The study of fatigue. The fatigue of workers is the uncontrollable item which has made difficult all attempts to develop standard task times which will hold over long periods. Attempts to make high wages on piece rates, and enthusiasm upon the part of the worker may both contribute toward the setting of a task time which seems possible of achievement over long periods, whereas it is really attainable only in spurts. Although the quantitative measurement of fatigue has not been successfully carried on as yet on a large scale, it is nevertheless desirable to consider this factor, its causes, and the means of prevention, in order to develop more intelligently fatigue allowances in setting standard time, and in order to find a fundamental philosophy toward the amount which a worker should be called upon to do.

Physiologically speaking, fatigue is the result of poisonous waste matter in the system and, since all labor produces this waste matter, to eliminate fatigue is to eliminate labor. There are two kinds of fatigue, normal and cumulative. Normal fatigue is weariness that is overcome by

rest and need not be considered as an industrial problem, as it may even be thought of as a wholesome fatigue which is similar to the pleasure derived from exertion in sports. Cumulative fatigue, resulting from overstrain, can be caused by too much work, too sustained work, or too monotonous work.

As fatigue has not been successfully measured quantitatively on a large scale, it is difficult to distinguish normal fatigue from cumulative fatigue, and this is the factor which makes fatigue elimination so difficult.

Signs of the presence of cumulative fatigue may be found in a study of production or accident records within an organization. If production tends to fall toward the end of the day or the end of the week, or if accidents seem to be unduly high at these times, it may be assumed that in the operations affected there is some cumulative fatigue which should be eliminated. These guides, particularly the guide of decreased production, may not be sufficient to detect the presence or absence of cumulative fatigue. This is particularly true on piecework. Pieceworkers, who have set a goal for themselves, are very likely to aim to reach this goal regardless of their physical condition, and the curves of production of pieceworkers, because of this fact, tend to go up at noon and at the end of the day. The workers with largest production under piecework are likely to be those who are building up an accumulation of overstrain, to the point where they leave the plant either because "the work is getting on their nerves" or for other stated reasons which have the same general foundation.

It is to be hoped that there will soon be a practical quantitative measurement of cumulative fatigue which will allow fatigue allowances in time study to be set with complete assurance, rather than partially on judgment. Without intelligent thought on the subject of the fatigue allowance, there is no positive check at present on the setting of a time which will produce cumulative fatigue. Practically, this is no great difficulty, since the intelligent time-study man can, by careful observation and analysis, prevent the evils of cumulative fatigue, such as pieceworkers would be likely to subject themselves to were it not for the job studies. Nevertheless, if there were some accurate measurement of quantitative fatigue, there might be more satisfaction, both for the job-study men and the workers for whom fatigue allowances are set.

All tests of fatigue, except one, seem to be valueless in this connection. Most tests, because they depend partially upon the will or the strength of the worker, have made it possible for the worker artificially to change real conditions while the test is in progress. For instance, such tests include strength tests or mental tests.

A quantitative test for fatigue. Dr. A. H. Ryan, of the Scovill Manufacturing Company, Waterbury, Conn., has to date made the most promis-

ing contribution toward the quantitative measurement of industrial fatigue. He has utilized a vascular skin reaction test which seems to give a fair measure of the extent of fatigue of a worker. This test consists in making a stroke on the surface of the forearm of the worker with a blunt instrument so devised that the stroke can always be made with the same pressure. The white streak which results from this stroke is studied with regard to its latent period, the time required for it to reach its maximum intensity, and the time at which it begins to spread and fade. The test seems to be somewhat successful, since the time elapsed before fading is decreased by work and activity, and increased by rest or sleep. The positive checks which to date have been made on this test seem to indicate that work which was considered the heaviest by foremen showed the greatest fatigue by the test; secondly, the fatigue seems to vary generally with the amount of output, providing the workers are working up to capacity; and, thirdly, in a comparison of percentages of accidents and illness on various jobs in consecutive years of employment, in the jobs showing the least fatigue by the vascular skin reaction, there was no rise in accidents or illness through years of consecutive employment, whereas in jobs showing the greatest fatigue there was a rise in the percentage of accidents and illness. This arouses hope for the securing of a practical measurement of cumulative fatigue.

Rest periods. Fatigue elimination to date has largely consisted of the bettering of equipment, as discussed under standard equipment; the elimination of useless and tiring motions, as developed by job study; varying the job so as to relieve monotony; and providing rest periods. Rest periods have been developed so as to provide a minimum of stated rest at intervals throughout the day, although a few companies, while providing the total minutes of rest periods which must be taken through the day, allow these to be taken by the worker whenever desired.

Stated rest periods of five, ten, or fifteen minutes during the morning and the afternoon are particularly successful with female workers. They are particularly successful if machinery can be stopped during these times.

Though rest periods do not result in the scientific elimination of cumulative fatigue, they do offer a palliative which is similar in effect to that of the noon hour. In cases where production falls immediately before the noon hour and in the late afternoon, or where accidents seem to be greater at these times, it will usually be found that such rest periods will even up the curve of production and reduce accidents throughout the day without a diminution of total output.

Monotony, and hence fatigue, is relieved if the type of work can be changed at intervals. One method of changing the type of work is by having the worker secure and deliver his own material. It is not always

profitable to bring material directly to the tool point of a worker and to take it away from that point; this is particularly true if the worker must remain in the same position at all times because of the nature of his machine. Thus, at the Joseph & Feiss Company, in Cleveland, it has been found desirable to allow girls working on various operations in the manufacture of clothing to secure batches of material from control desks, and to deliver these batches, when finished, back to the control desk, rather than to have persons move this material to and fro for the worker. Of course, this necessitates the determination of the proper size of batch, both from the standpoint of operations in the shop and from the standpoint of the elimination of fatigue, and this can only be determined after trial. Furthermore, such considerations must be closely controlled, or much confusion within the workroom will be likely to result. If the task be such that the worker may either sit or stand when performing it, it may be that such a plan will not be necessary.

Machine-delay allowances. In determining the machine-delay allowance, the percentage of machine time, as contrasted to the manual or "handling" time, should be taken into account. If the machine time be large, the machine-delay allowance must be correspondingly large, because of the greater likelihood of stoppages outside the control of the operator. Since this allowance makes provision for all details outside the control of the operator, it necessarily will be smaller in plants having well-developed planning departments and where material and equipment standardization has been given most consideration. The 10 per cent allowance made in the accompanying illustration from the Corona plant is relatively low and could not be justified in a plant which had not made the progress in these other phases of management work that have been made in this organization.

The correct percentages of delay allowances in any shop may best be determined by intelligent consideration of the first jobs studied and on the basis of the experience on these jobs for later jobs. That is, after jobs have been studied, and standard task times put into effect for them, record should be carefully made of operators' performances, and these should be compared for all jobs of similar percentages of machine time and for similar cycles and amount of physical exertion required. If the percentage increases of actual handling and machine times be thus compared with selected times, excellent data will be secured for the setting of delay allowances. The most scientific work along these lines has been described by Dwight V. Merrick, the formulae having been developed by the management movement's best mathematician, Carl G. Barth.¹

Total task time. After the allowances have been computed, the total

¹ See Merrick, D. V., *Time Studies for Rate Setting*, Engineering Magazine Co., pp. 17 and 60-65.

task time which is set as a standard for the operation is computed by adding the allowances to the selected operation time. Thus the task time in the illustration is found to be:

	Minutes
Selected operation time	1 25
Preparation time (not distributed)
Personal needs (3%)	0375
Fatigue allowance (2%)	025
Machine delay (10%)	125
Task Time	1 4375

CHAPTER XXIV

UTILIZING TIME-STUDY DATA

Regrouping old elements to set times on new operations. In shops manufacturing diverse products, it is impractical to take time studies on many orders being manufactured, both because of the cost and the promise of early delivery dates. It was shown previously that if the operations, when studied, are divided into their basic elements, these element times may be regrouped, and operation times set for new operations without further study. To be in a position to compile task times in this way implies not only excellent studies to begin with, but a well-worked-out filing system for the data that have been secured. Standard nomenclature of operations is a great aid here. Many concerns have been extremely successful in setting tasks in this way, as, for instance, The Link Belt Company, which, in its Philadelphia plant, has had remarkable success in setting rates on new products by time study, though handling time elements are secured largely from data that were collected years ago, some of them as early as 1905.

Much opposition is likely to develop to setting rates by a regrouping of elements unless this is excellently handled. It will be found true that there are comparatively few elementary operations performed in most trades, but that there are a great many combinations in which these few elementary operations may be performed. Nevertheless, great care must be exercised in reusing time-study data, to insure that the element in question is in reality the same element which has been previously studied, and that the conditions surrounding the new job are of such a nature that the previously secured information may be freely utilized without injustice to either the workmen or the management.

Setting standard rates. Time studies of the kind which have been discussed are taken not only for the purpose of improving conditions, but for the purpose of setting just and equable relative rates on jobs. The fundamental consideration in rate setting is that a rate once set must never be cut by the management. Any other policy results in workers' being fearful of turning out maximum production, lest the rate be cut. A complete discussion of the evils of rate cutting will be found in Chapter XXVI. Therefore, extreme care is necessary to insure that the rate is correct in the first instance. The actual setting of the rate may be in

UTILIZING TIME-STUDY DATA

PROPOSAL FOR STANDARD RATE AND TIME ALLOWANCE
CORONA TYPEWRITER COMPANY, INC.

OPERATION #4 DRILL ALL HOLES. PART NO. 2X92.

TO COST DEPARTMENT. DATE 8-5-

Please furnish the Method and Instruction Card Division with costs of the above operation as follows:

PER 100 PIECES			
MATERIAL	DIRECT LABOR	BURDEN	TOTAL COST
-	\$ 2.64	-	-
-	2.473	-	-
-	3.161	-	-
-	1.922	-	-

AVERAGE COST FOR LAST SIX MONTHS PREVIOUS TO 8-1-10
" " " " THREE " " " " " "
HIGHEST " " " " " " " " " "
LOWEST " " " " " " " " " "

PARENT RATE PAID AT PIECE WORK NONE FOR EACH 100 PIECES PRESENT BASE RATE NONE PER HR

REMARKS THIS OPERATION IS NOT SET ON PIECE WORK - FIGURES GIVEN ABOVE ARE FROM WAGE PAYMENTS OF HOURLY RATES.

REQUESTED BY H. V. WILLIAMS DEPT. 52

To be filled in by Methods and Instruction Card Division

PER 100 PIECES		
HOURS AT P W	HOURS AT D W	TOTAL AVERAGE
-	6.60	6.60
-	5.82	5.82
-	7.23	7.23
-	4.80	4.80

AVERAGE TIME TAKEN DURING LAST SIX MONTHS PREVIOUS TO 8-1-10
" " " " " " " " " "
HIGHEST " " " " " " " " " "
LOWEST " " " " " " " " " "

PARENT STANDARDE TIME ALLOWED NONE PER 100 PIECES PRESENT CLASS OF LABOR MALE

REMARKS FIGURES GIVEN ABOVE ARE FROM OPERATION RUNNING ON AN HOURLY RATE BASIS.

PROPOSED BASED ON OBSERVATION SHEETS 8-10-

PROPOSED STANDARD TIME ALLOWANCE 2.32 HRS. FOR EACH 100 PIECES

PROPOSED STANDARD RATE TO BE PAID \$ 1.878 PER EACH 100 PIECES

PROPOSED BASE RATE AT 100% EFFICIENCY \$.533 PER HOUR

PROPOSED CLASS OF LABOR MALE

PRODUCTION REQUIRED PER HOUR	AT 100% EFF.	PIECES	AT 80% EFF.	PIECES	AT 120% EFF.	PIECES
" " " " 8 1/2 HOUR DAY	396.6		317.3		475.9	
" " " " 8 1/2 WEEK	2191.8		1753.5		2630.2	
EARNINGS PER HOUR	.533		.426		.639	
" " " " 8 1/2 HOUR DAY	5.06		4.04		6.07	
" " " " 8 1/2 WEEK	27.98		22.36		33.54	

ESTIMATED LARGEST FIGURES TO BE MADE ON THIS JOB EFFICIENCY 115 EARNINGS \$.612 PER HOUR

ALLOWANCE NAME	PERSONAL	FATIGUE	MACHINE & TOOL	INSPECTION	TOTAL ALLOWANCES
PERSONAL	1.8				
FATIGUE	1.2				
MACHINE & TOOL	6.0				
INSPECTION	-				
TOTAL ALLOWANCES	9.0				

ESTIMATED LARGEST FIGURES TO BE MADE ON THIS JOB EFFICIENCY 115 EARNINGS \$.612 PER HOUR

ALLOWANCE NAME	PERSONAL	FATIGUE	MACHINE & TOOL	INSPECTION	TOTAL ALLOWANCES
PERSONAL	1.8				
FATIGUE	1.2				
MACHINE & TOOL	6.0				
INSPECTION	-				
TOTAL ALLOWANCES	9.0				

SETTING STANDARD RATES

267

(Actual working time required (within all allowances)):-

PER HOUR 51 MIN.

PER 1/2 HOUR DAY 8 HRS. 4.5 MIN.

PER 1 1/2 HR WEEK 44 HRS. 37.5 MIN.

(and in production due to allowance):-

PER HOUR 6.257 PIECES.

PER 1/2 HOUR DAY 59.44 PIECES.

PER 1 1/2 HR WEEK 328.49 PIECES.

GAIN or LOSS made by this proposal (at 100% EFF.)

GAIN IN PRODUCTION OF 24.57 PIECES PER HOUR COMPARED WITH FIGURES FOR LAST 3 NO S PREVIOUS TO 8-1-

LOWER DIRECT COST BY \$ 1.195 PER 100 PIECES 3 8-1-

LOWER TIME OF 3.43 HRS. 3 8-1-

GAIN TO OPERATOR DUE TO OPPORTUNITY TO INCREASE WAGES THROUGH PIECE WORK AND USE OF HIS TIME TO BETTER ADVANTAGE.

STATEMENT OF REASONS FOR CHANGE IN STANDARD AND GAINS OR LOSSES MADE

THIS OPERATION HAS NOT PREVIOUSLY BEEN SET ON PIECE WORK. FROM THE GIVEN FIGURES, IT WILL BE OBSERVED THAT, UNDER THE METHOD OF PAYMENT BY HOURLY RATES, THERE HAS BEEN A VAST VARIATION IN THE OUTPUT OBTAINED PER HOUR AND THE COST PER UNIT - THIS VARIATION EXISTING WITH ALL OPERATORS TO A GREATER OR LESS EXTENT. TO CORRECT THIS, IT IS PROPOSED THAT A STANDARD TIME AND RATE, AS GIVEN BE PLACED ON THIS OPERATION - COMPLETION OF THIS WORK IN ACCORDANCE WITH THIS STANDARD AT 100% EFFICIENCY, WILL RESULT AS FOLLOWS:- AN INCREASE OF 24.57 PIECES PER HOUR IN OUTPUT; A DECREASE IN COST OF \$1.195 PER 100 PIECES AND A SAVING IN TIME OF 3.43 HOURS FOR EACH 100 PIECES PROCESSED, WHEN COMPARED WITH THE CONDITIONS EXISTING DURING THE THREE MONTHS PREVIOUS. ON A BASIS OF AN ESTIMATED YEARLY PRODUCTION OF 100,000 UNITS, THIS WILL EQUAL A SAVING IN TIME OF 3430 MAN HOURS AND A SAVING IN DIRECT WAGE OF \$1195. (NOTE-THE PROPORTION OF DIFFERENCE BETWEEN THE HOURS SAVED AND THE WAGE SAVED, IS DUE TO THE ESTABLISHING OF A BASE WAGE AT 100% EFFICIENCY CONSIDERABLY HIGHER THAN THE AVERAGE HOURLY RATES PREVAILING UNDER DAY WORK CONDITIONS, THUS ABSORBING A LARGE PART OF THE ACTUAL MONEY SAVING MADE.)

THESE PROPOSED SAVINGS ARE MADE THROUGH SIMPLIFICATION AND ELIMINATION OF UNNECESSARY MOVEMENTS AND GREATER APPLICATION OF THE OPERATOR TO THE JOB, THROUGH THE STIMULUS OF PIECE WORK.

NO EXPENSE IS INCURRED FOR NEW TOOLS OR EQUIPMENT OTHER THAN A TOTE BOX FOR DELIVERY OF TOOLS TO JOB - ESTIMATED AS \$.75 CENTS.

NO CHANGE IN STANDARD TIME OR RATE WILL BE MADE BY THE TIME STUDY DIVISION ON ANY JOB UNLESS THE PROPOSED SCHEDULE IS AUTHORIZED BY PLANNING ENGINEER'S AND WORKS MANAGER'S SIGNATURE

WRITTEN BY H. V. WILLIAMS DATE 8-12-
ACCEPTED BY _____ TIME STUDY DIVISION

PLAN ENG
WLS DES

Fig. 94b.

the hands of the superintendent or the works manager of a plant, and he may be assisted by the personnel department in its final determination. It is the methods department, or whatever department of the plant actually makes the time studies, which has the real responsibility on its hands. Some system of proposal for a standard rate by this department is usually in vogue, and the accompanying illustration of a standard rate proposal from the Corona plant (Fig. 95) is an excellent example. It will be noted that the proposed rate covers the same job as the illustration previously used in connection with job studies. The rate is only approved by the works manager after it has been carefully checked by the chief of the planning department and himself.

A guarantee may be given the workman that the rate set will not be cut. This is usually placed on the instruction card which he receives. The policy of the Corona Company is an excellent example of what plant policy should be in rate guarantees, and the printed guarantee which goes to the workman along with the instruction card is reproduced in Fig. 98.

Instruction cards. The preparation and distribution to the worker of instruction cards, carefully detailing the method of work on a job, as well as the time that the various elements should take and the rate of pay, is an important follow-up of time-study work. This insures the utilization of the standard methods which have been devised during the job study and gives to each worker the best knowledge on methods of performance. It does not preclude innovation on the part of the worker, since he may recommend betterments, but it does insure that any new methods which are used will be better than old ones and that they will be equally available to all workers on a particular task. Some incentive must be offered to the worker to suggest betterments; he may possibly be allowed personally to retain the full benefits of any new methods which he may discover.

Three forms of instruction cards are illustrated. The one used by the Corona Company (Fig. 95) is a logical follow-up of their whole method of making job studies. The one used at the Jones & Lamson Company (Fig. 96) shows only one side of the card and shows how pictures of the set-up may be included on the instruction card as an additional guide to the worker.

Figure 97 illustrates an instruction card used by the Leeds & Northrup Company, manufacturers of scientific instruments. The relation of set-up time to productive time is clearly shown on this sheet. It also indicates necessary tools to be used.

Instruction cards as an aid to methods. Since methods improvement is one of the two purposes for taking job studies, the instruction card is invaluable in crystallizing for future use the best method for the job that has been developed by the study. Therefore, full information concerning

114-785-2824-20

INSTRUCTION CARD FOR METHOD OF OPERATION

Corona Typewriter Company, Inc.

Date Issued 8-23- 19 DRILLING Dept's copy Part No 2X92
 Operator No. 4 Name DRILL ALL HOLES.
 Time allowed at 100% efficiency for 100 pieces 2.39 Hours Rate paid for 100 pieces \$ 1.278
 Output required at 100% efficiency 41.75 pieces per hour Earnings at 100% efficiency \$.533 per hour
 Time allowed on rate board for 1000 pieces at 80% efficiency 29.88 Hours

DETAIL OF METHOD OF OPERATION

100% TIME ALLOWED

OPERATOR WORKS SITTING DOWN.

1. PICK UP ONE UNFINISHED PIECE FROM PAN ON TABLE, WITH LEFT HAND, PLACE IN JIG AND LOCK JIG. .10
 2. SLIDE JIG UNDER FIRST SPINDLE, DRILL TWO #40 HOLES IN TOP EDGE. TURN JIG $\frac{1}{2}$ OVER, DRILL ONE #40 HOLE THROUGH SIDE. .33
 3. SLIDE JIG UNDER SECOND SPINDLE, DRILL TWO #48 HOLES THROUGH SIDE. TURN JIG $\frac{1}{2}$ OVER, DRILL TWO #48 HOLES IN TOP EDGE. TURN JIG $\frac{1}{2}$ OVER, DRILL ONE #48 HOLE IN BOTTOM EDGE. .53
 4. TURN JIG $\frac{1}{2}$ OVER, SLIDE UNDER THIRD SPINDLE, DRILL TWO #9 HOLES. .16
 5. TURN JIG $\frac{1}{2}$ OVER, UNLOCK JIG, REMOVE FINISHED PIECE AND THROW IN PAN FOR FINISHED WORK ON TABLE. .06
 6. BLOW ALL CHIPS FROM JIG WITH COMPRESSED AIR. .07
- REST ALLOWANCE @ 5% .0625
- MACHINE AND TOOL DELAY ALLOWANCE @ 10% .125

(NOTE - ALL SPINDLES ARE OPERATED WITH HAND LEVERS.
 KEEP A HEAVY FLOW OF LUBRICANT ON DRILLS.
 KEEP MACHINE TABLE FREE FROM CHIPS, SO JIG WILL SET SQUARELY
 TEST DEPTH AND DIAMETER OF TWO HOLES AFTER EACH CHANGE OF
 #40 OR #48 DRILL)

TOTAL TIME ALLOWED FOR ONE PIECE

1.4375 hr.

Inspection Instructions

WALKING INSPECTOR:—SEE THAT ALL HOLES ARE DRILLED AND HOLES ARE CENTRAL IN STOCK. GAUGE LOCATION OF FULCRUM HOLE G543, ETC. GAUGE DIA. OF FULCRUM HOLE G1653, ETC. GAUGE LOCATION OF #40 DRILL HOLE G2520. GAUGE DIAMETERS OF #40 DRILL HOLE G, ST393; #48 DRILL HOLE G, ST233. GAUGE DEPTH OF #40 DRILL HOLE G1658 OR 1659; DEPTH OF #48 DRILL HOLE G1640 OR 1657.

NOTE—OPERATORS WILL NOT BE PAID FOR WORK REJECTED BY INSPECTORS ON ACCOUNT OF DEFECTIVE WORKMANSHIP

If Operation or instructions can not be performed as outlined or changes are required, notify the methods Division of the Planning Department immediately

Method Approved T. M. JONES Date 8-23-
 Rate and instructions approved B. R. BIGELOW Date 8-23-
Methods Div. Inspection Div.

FIG. 95a.

LIST NO. 94
 DEPT. NO. 3
 OP. NO. 1

OPERATIONS	SPEED R.P.M.	FEED	TIME	JCS. CUTTERS AND GAUGES
CHECKING			30 SEC	USE LERLANDIE DIVIDING HEAD
CUTTING	300	1/16"	40 SEC	CUTTER-104-2-1-OR STOCK CUTTER 3/16"
REMOVING			30 SEC	USE JACK FOR SUPPORT
CRANK BACK & TURN OVER			40 SEC	
			2 H 20 SEC	
			1 1/2 HRS	F.M.E.C.

FIG. 96.—Instruction Card with Photostat of Set-up, Jones & Lamson Machine Co., Springfield, Vt.

No.: Cat. 5300

INSTRUCTION SHEET

Major Operation: Engrave (S-8-Plate and Std. 131)

Name: Test Set
Operation Performed in Dept.: Shop No. 2

WORK TO BE PERFORMED IN OPERATIONS AS LISTED BELOW

Sub. Oper. No.	Detailed Instructions	Tools	Average Time Work Should Take	Time Allowed
1	First set up for engraving machine. Set up machine to engrave 20 characters on upper half of plate	Engraving master, fixture for holding plate and arrow gauge for S-2 and S-15 units.	6 5 min	30 min.
2	Engrave 20 characters as per above set up Check location of arrows using gauge			7 2 min.
3	Second set up for engraving machine: Set up machine to engrave 18 characters on lower half of plate	Engraving master, fixture for holding plate and arrow gauge for S-2 and S-15 units	5 5 min	15 min.
4	Engrave 18 characters as per set up No. 2 Check location of arrows using gauge			6 min.
5	Third set up for engraving machine. Set up machine to engrave serial numbers	Engraving masters for serial, and fixture for holding plate.	3 1 min	20 min.
6	Engrave serial (6 figures) as per set up No. 3			3 4 min.
7	Fourth set up for engraving machine: Set up machine to engrave arrow on Std. 131.	Engraving master and fixture for holding arrow.	.7 min.	15 min.
8	Engrave arrow on Std. 131 as per above set up.			8 min.
9	Take plates and Std. 131 to inspector, put away tools, and change time slip.			15 min

Total Engraving Time Required to Engrave 25 Sets				Total Engraving Time Required to Engrave 50 Sets			
Sub. Oper. No	Set Up Time	Productive Time		Sub Oper No	Set Up Time	Productive Time	
1	30 min.			1	30 min		6 hrs
2		3 hrs		2			
3	15 min			3	15 min		5 hrs
4		2 hrs 30 min		4			
5	20 min			5	20 min		2 hrs. 50 min.
6		1 hr 25 min		6			
7	15 min			7	15 min		40 min.
8		20 min		8			
9	15 min			9	15 min		
	95 min	6 hrs 75 min			95 min		13 hrs. 90 min.
	or				or		or
	1 hr 35 min	7 hrs 15 min			1 hr 35 min.		14 hrs. 30 min
Total Set Up Time				Total Set Up Time			
Total Productive Time				Total Productive Time			

Any change in design, material or conditions which affect the above time standards, should be reported to the Shop Engineering Department at once, so that necessary corrections can be made.

Worked Up by

Date

Fig. 97.—Standard Instructions for Producing a Scientific Instrument.

LEEDS & NORTHROP CO.,
PHILADELPHIA, PA.

Courtesy Leeds & Northrup Company.

set-up, tools, and methods of handling materials and tools is indispensable on instructions. If a worker, through his own initiative, can find a better way to do the job than that on the instruction card, every facility should be offered him to report this to the methods or time-study department. This forms one of the logical reasons for a suggestion-reward system, but such improved method should be treated as a suggestion, and the job method changed. On new work which is not likely to be repeated, the instruction card forms a means of securing a profitable method from the first. On work which is repetitive, after the first few times that the operation is performed, the instruction card is less for the guidance of the worker as to method, as he is probably fully familiar with this, than it is for supervisors who may be checking up the job from time to time.

The Corona Typewriter Co., Inc., agrees to pay the rate per 100 pieces as stated on any *Instruction Card*, only on condition that the method followed by the operator is in accordance with the conditions and instructions specified on the *Instruction Card*, and, the Corona Typewriter Co. Inc., also agrees to make no reduction in the rate of wage payment as long as the given operation conditions, instructions for operator, class of labor required and quality of work specified, remain in effect.

Supervisors and Assistants are instructed to cancel Piece Rate payments on all Job Cost tickets whereon the conditions, the method followed by the operator, or the class of labor assigned to the work is not in accordance with that specified on the *Instruction Card* or where the quality of work turned out by the operator does not equal the acceptable standard. Both Supervisors and Assistants are held strictly responsible for the enforcement of the above ruling.

The Management recognizes that there may be methods that are better or more economical than those contained in the *Instruction Card* and employees are requested to send any suggestions that they may have for betterment to the Planning Department, where they will be given full consideration.

FIG. 98.—Rate Guarantee.

The worker as an aid in checking time studies. To place full information concerning the methods of computing the task time upon the instruction card is one of the best self-imposed checks that a time-study department can possibly place upon itself. If this department is disposed to be unfair to the workmen it becomes more difficult to be so when the computations of task time are subject to the inspection of the worker. On the other hand, giving the worker a copy of the time-study results indicates to him that the time-study man was "square." Such procedure absolutely precludes the practice, which has been followed in some plants, of arbitrarily reducing task time in order to overspeed workmen. This action must be coupled with the idea that the workman may call attention

to selected element times which he feels are unjust and unreachable. If it were always possible to use only the one workman who was time-studied for the particular job all this precaution would be unnecessary, but since this is impossible every precaution is necessary to insure full and hearty response from each workman.

There is frequently a complaint made by some operator that he is unable to reach the standard of performance that has been called for on the instruction card. This may be due to one of the following causes or a combination of several of them: lack of skill on the part of the operator, trouble with his machine or equipment, delays which may have passed unobserved on the part of the time-study observer because they did not happen to occur while the study was being taken, or an incorrect time study. If an operator seems to be unable to make his task time with any degree of regularity, and it is clearly not his fault on the face of conditions, it is essential that a new study be made to check the time study that has been taken, so that it may be finally determined whether or not the task time that has been set is a fair one.

Production studies. The new study that is made has been termed by some time-study men a "production study." It usually consists of the observation of the operator during an entire day's time, or such part of the day as he is working on the operation concerning which he has made complaint.

During the observation of the worker in this "production study" a careful record is made of all times consumed, including a record of the element times, in the same way that these were recorded when the time study was originally taken. The particular value of this type of study is twofold: An opportunity is given to check the task at another time and therefore to see whether the delays which occur are practically the same and caused in the same way as those noticed when the study was originally taken; and second, an opportunity is given to see the effect of fatigue upon the worker, inasmuch as the study covers an entire day, which is an unusual length of time for an ordinary time study. A production study is, therefore, quite as much a fatigue study as it is a job study, and in reality consists of a combination of the two. It may conceivably happen that a time study which was accurate for jobs when they lasted only for several hours will prove to be absolutely incorrect for the same jobs when they are carried on throughout an entire day, because of the cumulative fatigue caused by carrying on the job for that length of time.

In order to insure accuracy in a production study, it is necessary that the element times be checked up against the selected element times of the original time study. The observer will usually do this, to some extent, as he goes along, so that if there are any great discrepancies he will be enabled to see the cause of these during the time that he is taking the

study. On the other hand, much of the result of the production study can only be secured by the working up of the data at its conclusion. The charting of the times consumed during certain hours of the morning and the afternoon may give the necessary information concerning fatigue upon which to base recommendations of change in time allowed for the task, or possibly on which to recommend relief from fatigue by means of rest periods.

Often interesting data will be obtained from the production study which will in short order direct the attention of the observer to the causes of the workman's inability to make his task. For instance, if it should be found that the elements which were entirely handling time were being performed well within the selected element time, while the elements which were entirely machine time were running uniformly larger than the selected time, it would quickly indicate that there was something wrong with the equipment or the method by which it was being used. At any rate the production study will clearly reveal whether the particular operator is unable to reach the time that has been set because of the conditions of the time or the conditions of the job, including himself. It may reveal the fact that he is leaving his machine more frequently than is necessary, that he lacks skill, or that the handling time and the time for the adjustment of the machine are unduly large, or it may reveal the poor condition of the equipment, in case that be the difficulty. The value of the production study cannot be over-estimated. It is the means of rectifying errors in time study, and keeping the rates that are set uniformly correct throughout the shop, and therefore keeping the attitude of the workmen toward the management uniformly good as far as the setting of task times is concerned. Production studies assist in applying the exception principle to time study, since only those jobs which are the exception, in that correct standard times cannot be set from short observation, are subjected to day-long study.

Studies of automatic machinery. Production studies deal primarily with delays and their causes, whereas time studies ordinarily deal with the proper times for performing elements of operations, and although they are concerned with delays, these are merely incidental. One class of time study in its original form is similar to a production study. This includes all time studies on automatic machinery. Automatic machinery, when once started, is supposed to continue in operation until the supply of raw material which is fed into the machine is exhausted. On many such machines provision is made for the continuous supply of material, so that there is supposedly no cause for the stoppage of this machinery during working hours. It would seem futile to take time studies on this type of machinery or operations involving its use. As a matter of fact, such operations are among those of which it is most profitable to take

time studies, and where the results achieved in proportion to the energy which is expended are likely to be large. In taking time studies of this type of jobs, the study takes the form of finding out the causes for delay rather than what the time of various elements should be. The times for the elements are involved in the continuous operation of the machine, which is also an important field of study for a methods department, but does not necessarily involve time study.

It is impossible to operate automatic presses, screw-cutting machines, looms, or any other type of automatic machinery without interruptions; but a study of interruptions determines whether the worker or the machine is the cause of failure to reach the set task. Small automatic screw-machine shops have often proved a source of large profit on small investment to their owners. On the other hand, similar shops have proved to be white elephants on the hands of other owners. The difference largely lies in whether or not the machines have been kept producing throughout the working day. In all automatic machinery, tools become dull or require changing, the material supply may run low, or there may be a number of other causes for stoppages. A time study of such machinery involves taking a production study for a period of a day or more, to determine which of these stoppages are avoidable and which are unavoidable. When this information is at hand it is possible to set a rate of stoppages which will apply to that machine at all times when working on the class of work studied. This will enable the shop to set tasks on the automatic machines which will be entirely within reach, in the same way that they may be set on any other machines in the shop. The setting of the tasks merely involves taking the capacity of the machine and deducting the allowance which has been found to be necessary by the production study that has been made.

In all time studies, but particularly in the taking of production studies, it is clearly evident that the high standard which was set up for the observer must be lived up to, if results are to be secured from the study. The powers of analysis of the observer include the ability to recognize facts as such, by separating them from attendant circumstances and from opinion. Initiative, ingenuity, energy, and imagination are all essential for originating ways and means of making the necessary separation of facts from theories, and the means of testing the reliability of supposed facts. The task-setter must be able to combine results and make deductions from his investigations. It is of small use for him to be able to separate if he cannot also build up and construct, of separate parts, a finished whole. He should be able to see clearly what the results of his minute study indicate, but he must at the same time be able to recognize the limits of the application of the facts deduced. Though rate-setting may be his primary object, he must remember that standard methods make for standard performance which insures that rates may be maintained.

PART VI

WAGES

CHAPTER XXV

THE BASIS OF INDUSTRIAL WAGES

The power of wages. The most important employer-employee relationship is that of wage payment. All other phases of their relations rest squarely on the payment of what seems to be an adequate wage. The dollar sign is the universal countersign in the industrial world. It is the best key with which to open the door of production or industrial peace. If wages are "right," many steps toward the betterment of employer-employee relations may be advantageously taken. These steps cannot be taken if contentment wages are not paid.

The reasons behind this most important position of wage payment in industrial management are readily apparent when the effect of the setting of the wage upon the life of the worker is considered. Ordinarily, the scale of living of the worker is, at any time, directly dependent upon the wage which he is receiving and its purchasing power. He, ordinarily, has no accumulated surplus upon which he can draw and no other sources of income besides his daily wage. Therefore, the wage that is paid places or lifts restrictions on the home life and recreation of the worker, and reaches into his home life in a way unknown to any other management factor.

All of this has brought most factory managements to a realization that wages are the most important power factor in the shop. Let us return to the idea which was used in connection with the development of modern industrial organization, namely, the idea of comparing such an organization to the modern power-plant development which is flung across a stream. Wages may be looked upon as the inherent source of power which makes the turbine representing the organization revolve. The greater the wages that are paid, up to a given point of maximum return, the more effectively the organization will operate. The smaller the amount of wages, or inherent power, that is allowed to flow through the organization, the less developed power may be expected as a return. But the utilization of this great power force is not simple. Wages paid

cannot be considered in the absolute, but must be considered relatively to those paid by other companies in the same field of business, or in the same community, and in relation to the economic needs of the workers.

Relation of the method of wage payment to the wage problem. Furthermore, the method of payment must be considered. In a power plant, the angle at which the water impinges on the blades of the turbine is an extremely important factor in its efficiency of operation. Likewise, in the utilization of this industrial force, the method of application of the force to the organization is an extremely important factor. Especially designed wage-payment systems may be utilized so to develop the inherent force of the wages paid as to secure the maximum results. This, then, is the relation which exists between a particular method of wage payment and the wages problem in general.

The satisfactory wage. No particular method of wage payment will succeed unless the basic wage is right. There is little spurring action in the development of a bonus system where the bonus is, in fact, merely a portion of what elsewhere would be a basic wage. The determination of the basic wage is thus the most important consideration in wage payment. The determination of the amount of wages paid under our industrial system rests primarily with the employer, but it nevertheless must be satisfactory to the employee, and is limited by its acceptability to the employee individually and collectively, at times by the general attitude of the community, and possibly by some state action. Thus, instead of a basic wage which is set entirely by the employer, there is found a basic wage which is ordinarily termed "right" or "satisfactory." There can be no general definition of the meaning of a "satisfactory" wage, inasmuch as its limits will differ so greatly under varying conditions. However, it can be stated that a satisfactory wage must bear the scrutiny of employees and at times of the community. The general attitude of the community will not be likely to affect an individual plant except in cases where that plant is the main or basic industry of the community, or except in cases of localized industry where a large portion of the community, other than those who actually are at work in the plant, secure their livelihood as a result of the wages paid within the factory.

Not infrequently we hear satisfactory wages spoken of as though they were "just" wages. In order to indicate the inaccuracy of such an idea and also to prevent wonder when a so-called "just" wage is attacked by the employees, it will be well to examine the fundamentals of what constitute "just" wages.

What are just wages? Any true idea of just wages must necessarily include a concept of payment to wage-earners on the basis of their contribution to industry, as well as some concept concerning the right to a fair living of an individual engaged in the productive process. The con-

tribution of an individual or, in other words, his "productivity," has never been satisfactorily measured under our present industrial system, and it is questionable whether it can be measured. Our whole life is so complex, and the relations of one person to production are so inexact, that it becomes practically impossible to determine the extent to which he or she has added to the goods of the world. Prior to the factory system, it was more nearly possible to arrive at some concept of the productivity of an individual, but the factory worker of to-day is performing but a very small part of the production of the article on which he is working. The machine on which he works and the building in which he works have not only been furnished and designed by the employer and the management, but have, in the first instance, been created by other workers. A knitter working on a complex knitting machine contributes much to production of the finished product which comes off of that machine. The question remains, how much of the production is made possible by the workers in another factory far removed, who made the knitting machine. These other workers were engaged in the production of machinery because of the capital and foresight of those who founded and operated that enterprise. Probably parts of the machine were made by still other workers in another plant working under similar conditions. How much of the product of industry belongs to each of these workers? How much actually belongs to each of the employers, to each of the managements, or to the salesmen who are selling the machinery, or the finished knitted product? That is the question which must be decided if an attempt is made to develop a just wage based on productivity. It becomes immediately apparent that this is practically an impossible task, and our idea of justice must be tempered by other considerations.

Presumably, regardless of the productivity of the individual, there is a point below which wages must not go, in order that the individual and the persons dependent on him may survive. This is seemingly the lower limit of a just wage but, in particular cases, even this lower limit must presumably be cut under if, for the moment, the industrial establishment in question is to survive. There are certain ways in which a given wage may be regarded by those intimately concerned with it which aid in determining whether or not that wage approaches a just wage. Probably that is as far as anyone can go at the present time.

Measurements which aid in considering the justice of a wage. There are two measurements which aid in the determination of this approach to justice. The first is that the wage must represent the results of a convincing effort to divide the product of industry on a fair basis. The wage which is paid because the employment manager calls up a manufacturers' association on the telephone to find out from the secretary what "is being paid for a given class of job" at a given time does not represent any such

effort. On the other hand, many organizations have wrestled with the problem and have come to conclusions which indicate that justice is being approached.

The second measurement is that the wage must command the support of all groups connected with the industry and of the community at large. If this is the case, it may be presumed that the wage is approaching a just wage. However, because of all the factors which have been described, it is better to think of the proper basic wage in industrial plants as being a satisfactory wage rather than as being a just wage.

The bases of satisfactory wages. There have been set forth three main bases as those which determine the satisfactory wage. Certain individuals have pointed to each of these as being the true base which sets the wage. These are supply and demand, the cost of living, and individual productive capacity. It is probable that in most instances all three aid in the determination of the basic wage rate, but no single one alone sets the rate. Supply of and demand for a given type of labor unquestionably have a large influence on the wage paid in most plants at any given time. With this fact in mind, both employers' and workers' organizations attempt to influence the supply of labor in the direction of their interest. Thus the spoken and written word of many employers indicates that they feel that there must be a pool of unemployed in order to bring the best results for industry, and that when the worker population in this pool becomes small, steps should be taken to increase it promptly. The attitude of many employers to the immigration problem is indicative of this. The workers, through organized labor and its attendant policies of the closed shop, restriction of apprentices, and elimination of overtime work, have conversely sought to limit the supply of workers. As either the employer or the employee gains the upper hand in connection with demand and supply for workers, wage rates are seen to fluctuate.

Thus, wage rates are frequently set largely on the basis of what the worker can be secured for, that is, what he can get elsewhere. Large organizations having plants in different cities pay different wages in each plant for the same work, depending upon what the wage levels in these communities are. Some companies, which operate largely on this basis, at times have different rates for the same job within one plant. For instance, in some of the glass plants of southern New Jersey where the supply of boys as helpers has frequently been the limiting factor in production, the man with the most boys has at times commanded the highest pay for his own labor. Factories that use supply and demand as the main or only basis for payment of wages usually are the first to decrease their wages in times of depression, and the first to be forced to raise their wages in times of increasing prosperity. Base wage rates which are set entirely on this policy imply fundamentally a policy of drift.

Cost of living as a factor in wage payment. The cost of living has gained increasing attention as a means of fixing base wages. The idea involves a decrease or increase in the basic wage dependent on the rise or fall of commodity prices and other factors which influence the budgets of individual workers. Cost-of-living statistics have been collected on an increasingly large scale and have been used by an increasingly large number of organizations which are attempting to set satisfactory wage levels within their plants. Although cost-of-living figures are extremely satisfactory as a check on base rates, nevertheless one of the most unsatisfactory features of them is that they are ordinarily based on the "average family." This usually consists of a man and wife and two or three children. The position of the single man, or the man with seven children, is thus thrown into question, if these cost-of-living figures are extensively utilized. A number of plants utilize figures of the Bureau of Labor Statistics, Department of Labor, of the United States Government. Other plants use state figures, while other concerns have made attempts at the collection of figures which relate more specifically to their own problems. In this latter class may be mentioned the H. H. Franklin Manufacturing Company at Syracuse, N. Y., which has, for some years, collected cost-of-living statistics in the city of Syracuse at intervals; Cheney Brothers, South Manchester, Conn.; Holt Manufacturing Company, Peoria, Ill.; The Palmolive Company, Milwaukee, Wis.; the Philadelphia Rapid Transit Company; The Printz-Biderman Company, Cleveland; and the Shell Company of California.¹

A fundamental difficulty in using cost of living as a basis in settling industrial wages lies in the proper definition of the term "living." No two series of figures on living costs agree, because they do not contain the same items. Even the figures of the United States Bureau of Labor Statistics have been roundly criticized by some who feel that they do not take a sufficient variety of expenditures into account, and yet these same figures have been criticized most frequently because they are too liberal. What is the difference between "cost of living" and "scale of living"? Habits, custom, and environment all influence an individual's idea of what constitutes the cost of living. The American worker of to-day views as necessities many items which are regarded as luxuries by European workers, and were entirely out of reach of all except a few of the nobility prior to the development of the factory system.

Any thought of using cost of living as a basis of industrial wages must include the willingness to increase wages as scale of living increases, if the wage scale is to be successful.

Productive capacity as a basis for wages. Individual productive

¹ See Bulletin of the United States Bureau of Labor Statistics, No. 369, The Use of Cost-of-living Figures in Wage Adjustments.

capacity cannot serve wholly as the basis for setting wage levels. It can be viewed as a partial aid in setting relative wage rates, and all of the work in job study and in the development of particular wage-payment systems which has been lately carried on in industry has this in view. If a sales manager is to be employed, it is to be presumed that he will be paid at a higher rate than a laborer in the shop. This is not entirely due to supply and demand, but is partly due to the concept of individual productive capacity. This factor, therefore, influences very largely all wage rates which are set, but any thought that it governs them entirely will come back to the idea that the exact contribution of wage-earners can be measured. It has been demonstrated that this is difficult, if not impossible. The influence of individual productive capacity is felt on original rates granted members of a working force, but has greater influence on changes which are made in these rates after employment. Many wage systems have been developed with the thought that individual productive capacity can be measured, and the defects in this reasoning must be considered before approval is given to any such system.

Payment of wages above the community level. Many plants have given up entirely the idea of determining exactly what the basic wage should be, and have fallen in with the thought that the greater the wages which can be given to the employees, the more will be the inherent power provided in the organization. Henry Ford was the first great industrial leader who paid wages above the community level on a large scale. Although Ford wages, owing to relatively inflexible minimum rates, have been alternately above and below community standards as cost of living and the minimum have changed, yet Ford personally has been committed to a high wage level. It was Ford who first gave the view of the value of high wages as a means of sustaining purchasing power to the industrial world. Although all industries are not in as favorable a position to pay high wages as the automotive industry has been, the lesson learned from this industry has been applied throughout the United States, and everywhere there is less tendency to economize by reducing wage levels than there was just a few years ago.

There has been a revolution in the thinking of industrial executives on wage levels. Although many companies, by necessity or by desire, still pay wages that are below the cost-of-living levels, nevertheless a contentment wage has displaced the minimum allowable in the community, as the basis of industrial wages in thousands of enterprises.

That high wages do not necessarily mean high labor costs, but, properly utilized, may mean low labor costs, is well understood by the modern school of industrial managers. Therefore, the determination of the economic basis of setting wages becomes less important as a manager attempts to set wages on a level which is higher than that paid corre-

sponding workers in the community. The basis of most modern management steps involves the payment of higher wages than would be paid under the older types of management. This higher wage is returned through the lowering of overhead costs, due to increased production and other benefits that are secured by means of complete co-operation between the management and the workers. If this be the goal, together with the importance of wages as a factor in industrial management, the question of exactly how wage levels should be set decreases in importance.

The sliding scale. The sliding scale in wage payments involves arranging in advance reductions in rates when competitive conditions in the trade make these desirable, and increases in rates that will enable workers to share with the employer the benefits of times of prosperity. Under this scheme a basic rate is fixed to correspond with a determined selling price of some finished product of the industry, and then, with fluctuations of the selling prices, rates will drop or advance a predetermined amount. This method of wage payment finds little use in the United States, although it is used considerably more in Europe, particularly in England. It generally works to best advantage in negotiations between bodies of employers and unions, since it involves the acceptance of the plan on the part of employees, which is difficult to obtain except where they are organized. However, the recent development of the movement toward works councils has bettered the possibility of handling this system as a one-company affair. In such cases its workings are likely to be somewhat less formal, and to represent merely the enacting of community sentiment that wages should increase in times of prosperity and must be reduced in times of falling prices.

A formal sliding scale, adopted in advance, will not succeed where the commodity being manufactured does not have a wide, competitive market, with open quotations on current selling prices. Thus the sliding scale may easily be introduced into the manufacture of pig-iron because quotations on finished pig-iron are easily ascertainable. It may be introduced into cotton-spinning, because its fluctuations may readily be based on the selling price of a particular grade of cotton yarn. It is not applicable to a specialty business.

The method of determining the way the scale of pay shall fluctuate with the scale of selling prices is a matter for bargaining, but ordinarily the increase or decrease of the wage should bear approximately the same relationship to the increase or decrease of the selling price that wages bear to cost of production in the particular industry or plant.

CHAPTER XXVI

WAGE SYSTEMS NOT BASED ON JOB STUDY

A STUDY of wage-payment plans follows naturally a discussion of job study and analysis and the basis of industrial wages. From what has been said of the basis of wages it is evident that any discussion of wage systems may be handled from several points of view. For instance, it may be developed entirely from the point of view of the employer, entirely from the point of view of the worker, or from the point of view of the economic welfare of the community at large.

Wage-payment systems will be discussed here from the standpoint of management, that is, securing the greatest possible production from the worker compatible with his health and fullest co-operation. In considering these wage-payment systems it will always be well to keep in mind the requirements of the cost-accounting department of the business as well as of the production and general management forces. Systems which involve the collection of a multiplicity of data may conceivably succeed in increasing output and thus decreasing the unit cost of production, but fail because of the excessive cost and difficulty of collecting data for payroll and cost purposes.

The day rate. The payment of a certain amount to a worker for a certain period of time is usually known as a "day rate," whether the period of time be a day, a week, or an hour. The day rate is perhaps the oldest method of wage payment under our present industrial system, and probably more than half of the industrial workers of the United States are to-day being paid under some form of the day rate. Unless the worker be so inefficient as to merit discharge, or unless he be so expert as to be raised into a higher wage classification, it is unlikely that his individual rate will be changed. Thus the amount or quality of work which he does has little bearing on the wage which he receives, except over long periods of time. There is, under this system of payment, little to urge a worker toward greater production except loyalty toward his task or some spurring action on the part of his employer or his direct superior.

Under older management methods the use of the day rate ordinarily resulted in closer administrative supervision by the employer. Increased production by a worker under this system implies directly increased profits. Decreased production brings with it monetary loss which comes

directly from the pockets of the employer. Therefore, along with the day rate was ordinarily come careful attention to mechanisms that will increase production. It was an ideal system for an era of attention to the mechanics of production.

Many workers have favored the day rate, because under it they could definitely determine in advance what their wage would be. That all workers of a given class generally receive the same pay constitutes no objection for some workers. In fact they tend to favor it, because it implies a unity of action, through organization, of all members of the wage group, in case it seems possible to secure an increase of the rate. For these reasons, day rates, once raised, are frequently as difficult to lower as any other kind.

In the main, labor unions have tended to favor the day-rate system. Unions exist for the benefit of their membership as a whole, and therefore anything which will tend to increase the unity of purpose of their members is likely to engage their support. The day rate is a perpetual influence toward solidarity in the union. Substandard workers look to it as a means of raising their wage far beyond anything they could expect under piece rates. The average worker is likely to be satisfied with the prevailing wage. The best workers are likely to be striving constantly to increase their income, and in doing so will tend to increase, along with their own income, that of the other members of the labor organization. As a matter of fact, the best workers who, under other systems of payment, are least likely to be interested in unions, under the day rate are likely to be the prime movers toward organization. It is their only hope for increased wages. Thus they frequently begin to combat the management, whereas under other circumstances they may be made the management's greatest supporters among the workers.

Quality of product should be enhanced through the day rate. The workman, not being rushed, should be able to utilize fully his talent in those tasks where such expression is possible. Plants or departments in which quality is a paramount consideration are thus most likely to be on day rates. Nevertheless, effective foremanship and newer methods of wage payment make possible high-quality production without the day rate.

Payroll department operation is made simple by the day rate. The payroll may be prepared directly from the attendance time cards. On the other hand, cost-department operation is made more difficult. Production will vary greatly from man to man and from day to day under this system, and wages thus become a variable element of cost which cannot be predetermined. Thus, to plan production-cost budgets and selling prices becomes difficult.

Perhaps the chief objection to the day-rate system is that it is no

inspiration to any worker, good, bad, or indifferent, unless the urge toward quality be so considered. Utilization of the day rate is likely to bring with it the attitude that a certain amount of time must be put in between whistles, and that mere presence is all that is implied under the wage contract. There is enough leveling of opportunities for growth to commanding positions under the necessities of our industrial system, without unduly adding to it through the influence of a method of wage payment.

Regardless of the type of wage-payment system that may be in vogue, it is usually necessary to pay a certain percentage of the workmen by the day rate. This group of workmen will not only include supervisors, but any men whose work is so diversified, incapable of standardization, or temporary, as to make it impossible to work out a satisfactory wage under any other system of payment. Because of its ease of operation the day rate will probably continue to be much used as a system of wage payment.

The straight piece rate without job study. The second of the older plans of paying workers is to fix a price for the completion of a given task, and pay that price without reference to the time taken in completing the task. The task may be either the completion of one unit or of a given amount of work, and the rate is ordinarily termed a piece rate. Piece rates have been set usually with strict regard to previous day-rate earnings and previous performance. They have usually been determined by dividing the day rate by the average units of production, in order to secure the proper rate per unit. Sometimes the rate has been made somewhat less than this amount, under the assumption that production will increase under piece rates and that this will bring greater profits to the employer. But usually the employer has been willing, at the start, to profit only through the reduction in his fixed overhead expenses per unit of product. Since these expenses remain approximately the same and with greater production are distributed over more units, there should be profit to both employer and worker through such increased production. If a worker should be so poor as not to reach average production, his wage under the piece rate would be less than under the day rate, thus bringing a saving in direct wages in the case of substandard workers.

First-class workers handling repetitive work have usually been anxious to be placed upon piecework, inasmuch as it gives them an opportunity to realize on their accumulated skill and knowledge of the job. The direct monetary gain which results from study of the method of performing the job by the worker is likely to result in a keen study by him of the conditions which surround it. Within limits, he becomes receptive to improvements in methods promulgated by the management. He is not receptive to such improvements when he is fearful that they will be so marked as to result in cutting of the rate. Substandard workers and those working

on diversified work on which the setting of piece rates based on past performance is difficult are not likely to favor piece rates. Workers generally fear that the management, in setting rates on jobs where there is no accumulated mass of information concerning past performances, will protect themselves by making the rates so low that the worker will be unable to "make out," or earn the equivalent of the day wage.

Rate-cutting. The greatest defect in the piece rate in practice is one that in theory need not exist. That is the tendency toward rate-cutting. Although the employer is receiving benefits in reduced overhead charges, he is not likely to allow workers to continue for any great length of time to "kill" a job, that is, to get wages which are far in excess of the usual rate of wages for such work. Either the press of competition, or the desire for increased profits, or both, is likely to cause him to demand that the management cut the rates. Frequently this has been done under the assumption that if the workers do not like the change they can readily be replaced at the new rates. The action of rate-cutting is equivalent to informing the employees that there is a maximum of earnings beyond which workers of any general class will not be permitted to go. Such action, once taken in an organization, or fear of such action based on practices in other organizations, causes workers to hold their production under piece rates at the easily reachable figure which it is thought the employer has set as his maximum. If rates have once been cut, this figure will at times, through a shop, be so uniform as to amount almost to an exact limit. Unfortunately, there is no possibility of making clear to all concerned what the exact conditions surrounding a job set on the basis of past performance are. Unless there has been job study and careful analysis of elements, with resultant rate-setting, such as that described in Chapter XXIV, the workers have no certain basis on which to compare old rates and new.

Really radical changes in production method, which so change the job as to make the past rate absurd, have been frequently looked upon by workers merely as an excuse for cutting rates. Changes in method have at times been bitterly fought by workers for fear that under the new method and new rate they would be unable to make as high piece-rate earnings as under the old method. This confusion between logical piece-rate readjustments and rate-cutting results in numberless borderline cases which it is difficult to settle amicably, because there are no real data, convincing to both sides, which may be used as a basis.

Some executives, when pegging of production at a relatively low level has been pointed out to them, have indicated that this did not seem to them to be an objection to piece rates. Inasmuch as the worker is only being paid for the work that he is turning out, why not allow him to loaf? Such ignorance of cost accounting as is implied by this attitude is happily passing, but it clearly indicates the necessity of a check on management

that will force it to better its methods. Such a check is not provided by piece rates. Piece rates set through the aid of time study have few of these objections and will be discussed later.

The general feeling has existed for some years that a result of piece rates is to secure quantity at the expense of quality, unless a very rigid inspection system is installed. Opinion has been gradually changing in this regard, until now it is felt that proper supervision permits piece rates to be installed on practically any job, regardless of the demands of quality that are entailed. For instance, in the forming of high-grade pottery on the jiggering machine, piece rates are used. Lenox, Inc., Trenton, N. J., feel that there are great production economies in the use of the piece rate on this operation, which is the bottle-neck of quality in their plant, where the finest high-grade dinner ware is made.

If straight piece rates are used, it is essential that some provision be made for the learner. Inasmuch as there is no day rate guaranteed under piece-rate plans, it is necessary that a special "learner's rate" be established, which is usually on the day-rate basis. The length of time that the learner remains on day work varies with the type of operation and with the factory, as well as with the training system that the plant has installed. The learner's rate usually starts at a low point and gradually increases up to the point at which the worker is put on piece rate.

Piece rates have the disadvantage of being inflexible. Difficulty in the setting of piece rates is encountered when the whole level of rates paid workers rises and falls. If rates have been raised during periods of high wages, they are usually decreased during periods of depression and falling wages. Such lowering of wages is, of course, a cutting of the piece rate. This situation results in very perplexing problems which have been solved by some plants not by increasing piece rates, but rather by giving a "cost of living" bonus, or by placing the wages from an increased piece rate in a separate pay envelope, in case the rates were increased.

In times of depression, when orders are scarce, the piece rate has a great advantage over day rates or any of the newer systems which guarantee minimum earnings to the worker. Under such conditions many plants are operating from hand to mouth on orders, and this is as well known to the workers as to the management. The piece rate does not invite the worker to stretch available work, so as to insure himself a job under such conditions. In prosperous times, with orders plentiful, this ceases to be an advantage of the piece rate.

From the cost-accounting and cost-estimating standpoints, piece rates are far better than day rates, but not ideal, as contrasted with other systems. The direct labor cost per unit of product or per job becomes a fixed amount which may be accurately determined in advance. But, since the time of doing the work varies considerably, the amount of overhead

expense which will have to be distributed to an operation or an order is an unknown quantity previous to actual performance.

Incentive wage systems. In meeting the objections to the older systems of wage payment and developing methods which will prove to be lasting improvements, attention must be paid not only to proper remuneration of the workers, but also to proper remuneration of invested capital. Schemes can be devised which will prove entirely satisfactory to the worker but which will in time be eliminated by those controlling the enterprise because they will not be flexible enough to permit the meeting of increasing sales competition. Thus any wage scheme which gives the worker a percentage of the savings incident to increased production and yet prohibits innovations in manufacturing method or merely inclines to make the worker peg his production at a somewhat higher point than formerly, due to fear of ultimate wage-cutting, will not be beneficial for long. Rival plants, whose rates are set on the basis of newer manufacturing methods, or whose workers have not pegged production even at the relatively high level, will always be able to underbid, because of lower manufacturing costs. This is the basic reason behind changes of rates when the process or operation is changed. It is thus essential that any wage-payment system which is devised shall so arrange the remuneration that the permanent co-operation of both the workers and the stockholders' representatives shall be assured. No general rule can possibly be laid down concerning the method of arranging such remuneration which will apply to all cases. General lines of attack on the problem can be indicated, but these must be intelligently fitted to each individual situation.

In general, it may be definitely stated that unorganized workers like to work under one of the "incentive" wage systems when they are fully convinced of the fairness of the management and the fullness of information possessed by the actual rate-setters, as well as the competence of the latter. These systems plainly indicate to the workers that they are expected to perform up to their capacity, fatigue considered, while they are on duty in the factory. The older wage systems do not continually convey this information to the worker as do these newer systems. The day rate conveys to the minds of some workers that they are being paid for their mere presence within the factory walls, and under the piece rate it is frequently assumed by some workers that, since the management is only paying them for the actual number of pieces that they produce, there is no desire on its part that they should reach any particular maximum during the day. Incentive wage systems awaken the interest and put the spirit of competition into industry. They make it practical to arouse interest in work to an extent that can be achieved in no other way.

An incentive wage, in order to be effective, must generously reward the worker for the additional application, following of instructions, increase

in output, and quality of workmanship which is required in order that the additional wage shall be earned. Unless the reward for increased production is large enough the worker will not be stimulated to the increased production which is possible under such a wage system. It should be emphasized that cupidity on the part of management is like signing the death warrant of any of these incentive schemes of wage payment. If the reward is large enough the worker will be enabled to take new pride in his work, the pride of having earned more money this week than he did last, because he worked better and more effectively. The pride of accomplishment in relation to his fellow-worker develops. This is a perfectly logical and justifiable pride and does not necessarily result in the setting of a killing pace.

The schemes of wage payment which have been developed in recent years are about as numerous as the people who have been thinking about incentive wages. At least it is true that every industrial consultant seems to have worked out a wage system of his own, which he tries to demonstrate as being better than all that have gone before. In most cases, as far as fundamental difference goes, these particular schemes vary only sufficiently to allow them to be designated with the names of their authors. There are only a few fundamental ideas connected with these wage-payment methods, and it is these which we will consider. Of course, in the adaptation of these fundamental methods to the particular plant or department, minor changes will have to be made.

Premium plans—the Halsey Premium System. All premium plans of wage payment aim to give the worker some share of the saving in the costs of production which are earned by turning out the work in better time than the task, standard, or normal time for the job. One of the most common of these systems is the Halsey Premium Plan, named after F. A. Halsey, who devised it at the time he was superintendent of the Rand Drill Co., of Sherbrooke, Canada. The basic idea of it is to set a standard time, usually by ascertaining the average previous time of doing the job, and to offer the workman an agreed percentage of the wages of any portion of this time that he may save, in addition to his hourly or daily rate for the time consumed on the job.

Although, as originally conceived and generally used, the standard time under this plan was the standard of past performance in the shop, there is no reason why a standard time determined from time study cannot be used under the Halsey plan. However, since the Halsey plan gives the worker only a portion of his saving, if time study be used as the basis, it is essential to set the standard time somewhat higher than the time which can be made, in order to provide sufficient incentive for the worker. The task time set by job study thereby becomes a base for the management to work from rather than a task to be reached. However, under the Halsey

plan, the standard time is usually the average of previously recorded times. It is usual to guarantee that when the time is once set for a job it will not be reduced, despite the fact that conditions may not have been standardized, or the jobs studied. The system is liberal with the time allowance rather than with the premium percentage.

Day rates are guaranteed under this plan, and to men who finish their tasks in less than the allotted time there is paid, in addition to this base day rate, a proportion ranging from one-quarter to one-half of the wages of the time saved. Thus the wage under the Halsey system is equal to the time taken, times the hourly rate, plus the time saved times some fraction of the hourly rate. The fraction of the hourly rate that is most generally used is about $33\frac{1}{3}$ per cent, in case conditions have not been standardized or the job studied. If the job has been studied, the fraction of the hourly rate that is used will ordinarily range around 50 per cent. The percentage of the time saved—from 30 to 50 per cent—is likely to represent a rather part large of the total wage, and to make the percentage larger would be apt to create a distinct temptation to the employer to reduce the standard time when shown that it was considerably longer than actually necessary.

To illustrate the working of this plan, we may consider the case of a workman who is on an hourly rate of 50 cents per hour, and has an eight-hour task given to him, which he completes in six hours, working with a bonus of $33\frac{1}{3}$ per cent of the save time. He will receive:

$$\begin{aligned} 6 \times \$0.50 &= \$3.00, \text{ the hourly rate, and} \\ \frac{1}{3} \times 1.00 &= .33, \text{ the bonus} \\ \text{Total} &= \$3.33, \text{ for the job} \end{aligned}$$

It will be noted that he received \$3.33 per six hours' work, which is at the rate of $55\frac{1}{2}$ cents per hour, or at the rate of \$4.44 per day, providing his time on the next job which he may start immediately is as good as the time on this job.

The Halsey plan is easy to introduce. It is not absolutely necessary that there be preliminary studies, other than those which will determine previous times on the jobs, and the plan is therefore excellent in any shop as a sort of transition plan to be used while studies of the jobs in the shops are being made and to arouse the interest of the workmen in incentive wage systems. This plan, in a slightly modified form, received its greatest amount of advertising from its use in the shops of the Yale & Towne Manufacturing Company. It was used as a transition plan in this case, since it has been largely supplanted by other incentive wage systems.

One of the chief merits that are urged for the Halsey plan is that it makes for the permanence of the rate because of the method of division of the profit on saved time between the employer and employee. If an

extremely large time is allowed for one job, and as a result the workman makes a very large saving of time, only a portion of the saving is given to the workman, which prevents the employer from having an immediate desire to slash the rate. The plan is also very simple and not as confusing to the workman as some of the other plans. It is perfectly simple for any man, when he knows the standard time and the actual time, to subtract the actual from the standard, and then perform the simple calculation noted above.

If the Halsey, or any other premium plan, is used as a transition plan, much care is needed to see that it is so arranged that wages under it will not be higher than wages are to be under the permanent plan adopted. With increased study of the job, it is possible that toward the end of the use of this plan in the transition period the worker may earn very high wages, wages which cannot possibly be maintained over a long-run period. Naturally the permanent plan will be looked upon as a method of cutting wages if the amount in the pay envelope at the end of the period is less than under the transition plan.

Since premium earnings often total a very large percentage of the total wages, the plan is criticized from the management point of view in that standard times prove in practice to be so very high that a temptation to reduce standard time in one way or another is sure to come eventually. And further, standard times are sure to be uneven in that some will be very high and some will be comparatively low, which results in an unjust payment plan with "fat" jobs and "lean" jobs. In such cases there will tend to grow up a picking and choosing of jobs among the workmen, or criticism of the allotment of jobs among them, just as in any piece-rate plan where the piece rates are variable in their earning capacity. Furthermore, the workmen can beat the game by spurting on certain jobs to earn a premium, and "soldiering" on other jobs to rest up under the guarantee of day wages.

The Rowan Premium Plan. Another typical premium plan, which has received much attention, originated in a Scotch establishment, David Rowan & Sons of Glasgow, being developed by Mr. James Rowan of that firm. It is used more extensively in Great Britain than in this country, although several large American concerns, notably the Packard Motor Car Company, have adopted it in parts of their factories. Although a premium plan, like the Halsey, it differs in the method of computing the premium and in the base used. Wages, instead of being increased by an arbitrary percentage, applicable to all similar jobs, are increased by a percentage equal to the percentage of reduction which the worker has made on the standard time of the particular job. This premium is a percentage of time worked, rather than of time saved.

If the time be cut 40 per cent, the premium is 40 per cent. Thus if a

workman whose rate is 50 cents per hour finishes a ten-hour job in six hours, saving thereby 40 per cent of the time, he receives the hourly rate for six hours, or \$3, plus 40 per cent of this, or \$1.20. This makes the job rate \$4.20, or 70 cents per hour, which is at the rate of \$5.60 per eight-hour day. It will be seen that ordinarily the premium is larger under the Rowan plan than under the Halsey plan. If the Halsey premium be $33\frac{1}{3}$ per cent, the Rowan premium will always be larger up to $66\frac{2}{3}$ per cent of time saved. If the Halsey premium be 50 per cent, the Rowan premium will be larger up to 50 per cent of time saved. Thus, in most cases, the Rowan premium is larger.

Although it is somewhat easier to justify the percentages used under the Rowan plan than those under the Halsey plan, nevertheless adaptations of the Rowan plan are far less used, chiefly because the method of figuring wages is too difficult, and the worker finds it hard to understand, and harder to know what he has earned at any given time. It involves the use of a large clerical force for payroll purposes. As the use of standard costs (described in Chapter XLVII) spreads, the use of such premium plans as the Halsey and Rowan must necessarily decrease, because cost predetermination is almost impossible.

CHAPTER XXVII

WAGE SYSTEMS BASED ON JOB STUDY AND TASKS

INCENTIVE wage systems which are developed to have workers make a set task rather than beating a set task are most suited to the demands of modern management. Budgeting, standard costs, and the control of the several phases of a business all are assisted if the approximate time required to perform tasks can be predetermined. Therefore, wage systems that are constructed on past performance which it is expected that the workers will better are no aid to other phases of management. Wage systems based on accurately predetermined tasks urge the worker toward performance in the standard time which serves as the basis for management controls.

Piece rates without job study and the premium systems permit drift in management methods. Wage systems based on job study prohibit management from drifting, because standard conditions are a preliminary step to the development of all such systems. Since the task has been accurately set on the basis of fair time for the job, the worker must receive all of the advantage which he gains by the reduction of working time below task time. Therefore, these systems push the management quite as much as the management pushes the worker.

The higher rates which the workmen earn under all of these systems must necessarily take into account the fact that the management, as well as the worker, has had a hand in the increased production which is being secured. The employer has given more of his thought and money for the installation of the new conditions under the operation of these wage systems than in the operation of the premium systems previously discussed. The employee, on the other hand, must give somewhat more concentration and possibly lose some of the pleasure which may be presumed to come from freedom to do the task in his own way. He should, therefore, be paid a larger bonus for accomplishment under wage systems based on job study.

Piece rates based on job study. Piece rates based on job study form the simplest incentive wage and generally a very effective one. Piece rates so set readily can be guaranteed by the management, provided provision for change in rate, if the operation be changed, is made. Piece rates thus set become an incentive wage because the worker realizes

that there is no possible cause for him to peg his production at any point. In order that such rates actually may be an incentive wage it is essential that, after turning out the increased production made possible by the job studies, the worker's wage be appreciably higher than his previous or the prevailing community wage. The satisfactory administration of this system requires that if, for any reason not within his control, the worker is placed on a new job, one that he is unfamiliar with, or one that for any other reason, through no fault of his, he cannot make his high rate on, he should immediately be placed on a guaranteed day wage. This rate may best be the average of his piece-rate earnings over a definite, previously determined period. This plan is coming into very general use. It is simple and easily understood and does not involve any of the complexities of some of the more elaborate systems which will be described. If accompanied by the guaranteed day rate, it places the desired share of responsibility on the management.

Day rates based on production. These are of two types, (1) a series of day rates based on productiveness, or (2) one high day rate based on a high standard of performance. The utilization of a series of day rates based on performance provides for a number of classes of operators for any given task. These classes have their limits, fixed by the production of the workers in them. As the productiveness of an operator increases, or decreases, he moves from one of these classes to another, and consequently has his rate changed. If records have been accumulated, covering the performance of a number of workmen, it will soon be found that the workers will divide themselves off into fairly well-defined classes which can have different rates of pay assigned to them. It is unnecessary that the individual worker be working always on the same job or type of job to utilize this system. In case a record of the individual productive efficiency of each worker is kept on whatever task he may be working on and then all the workers are divided into distinct wage groups, based on their general efficiency, rather than their efficiency on any one particular task, this system may be used on all jobs. Under a scheme of this sort, advances or decreases in the worker's rate may be made at intervals of one month or three months, or at any other period that is deemed best by the firm.

The second type of day rate based on production provides for day rates for jobs rather than for workers. Each job has a day rate assigned to it, which is far larger than the worker can earn by the ordinary day or piece rates that have been in force in the factory up to this time. At the same time that this high day rate is placed on the job, a standard is set for that job. If the worker makes the standard or better, he receives the high day rate. If he fails to make the standard, he drops back to the former piece rate of the job, or a new piece rate figured out in such a

way as to make the worker suffer a loss in his pay envelope due to his failure to make the standard. Usually, for the most effective operation of this type of wage-payment system, it is necessary that the worker's performance be figured over relatively long periods of time, and that he be not deprived of the high day rate merely for failure to make the standard over a comparatively short time.

This system has the advantage of the ease in the computation of the payroll that is to be found in the day-rate scheme, and at the same time it enforces high production. It is very useful in plants where the workers object to working on piece rate, and where, therefore, the penalty of failing to meet the standard will not only reduce their wage, but will serve to place them under a wage system that they do not like. If the system is fairly devised it is usually easy to secure the co-operation of the worker.

In style industries in which new rates must be set constantly, the use of day rates based on production is much more simple than any other form of wage payment. Since a worker has had a day rate assigned to him, based on past performance, on short jobs that have not been time-studied, and which it may be unprofitable to time study, he may be given the day rate which he has had previously. He may also be kept on this same day rate while production standards are being worked out for new jobs on which standards ultimately may be set.

The differential piece rate. The differential piece-rate system of wage-payment was devised by Frederick W. Taylor, as the method to utilize after conditions had been standardized, jobs studied, and tasks set. The system has two piece rates, a high rate, which is paid to workers who achieve the set task or better, and a low rate which is paid workers who fail to achieve the task. The high rate is set at a point considerably above the community standard, while the low rate is set at a point below the standard of the community. Thus the task time for a given job might be two hours, with high rate \$1.25 for the task and the low rate 75 cents. If the worker did the job in two hours, he would receive \$1.25, or at the rate of \$5.00 per eight-hour day. If the worker took two and a quarter hours he would receive 75 cents, or at the rate of \$2.66 per eight-hour day. Although this last figure is somewhat misleading, since it may be assumed that no worker allowed to work under this system would fall down on every job during the day, nevertheless, it will be seen that the system is severe on the worker who fails to make the task.

The intention of the differential piece-rate system was to exert a strong pull on a worker to do his task within task time. The assumption was that the management had gone to great trouble and expense to insure that all management factors were properly working, and the only reasons for failure to do the task within the allotted time would be within the control of the worker. If the worker were a first-class man, he would

make his task. If he were not a first-class man, and could not be trained to be a first-class man, he would not be wanted, and, in fact, if he continuously failed to make his task he would be discharged. First-class men, making their task, would receive a compensation which would distribute between them and the management the savings of greater production.

The Taylor differential piece rate is not found, in its original form, in extensive use in industry to-day. The culling action at the point of achieving the task was found to be so extremely severe that the measurement of the task and the control of conditions set for the workmen had to be guarded with extraordinary care, in order to avoid complaint or feeling of injustice on the part of the workmen. The fact that the Taylor differential piece rate does not guarantee a basic day wage is, therefore, the primary reason why it has fallen into disuse. Mr. Taylor recognized this point himself, for he said, "When, however, the work is of such variety that each day presents an entirely new task, the pressure of the differential rate is sometimes too severe. The chances of failure to quite reach the task are greater in this class of work than in routine work, and in many such cases it is better, owing to the increased difficulties, that the workman should feel sure at least of his regular day's rate."¹

The differential piece rate has been modified by some plants, and is used in this modified form. This modification takes the form of making the lower rate equal to the prevailing rate in the community, rather than making it below the prevailing rate. The higher rate remains as before, far above the local average piece rate. The system then becomes essentially the same as the piece rate based on job study; except that there is still a sharp break at the point of the task, and the same as the task-and-bonus system, except that there is no guaranteed day rate as in the latter.

The task-and-bonus system. The system known as the task-and-bonus system was devised by Mr. H. L. Gantt while associated with Mr. Taylor in his work at the Bethlehem Steel Company. In the later years of Mr. Taylor's life, he became a very hearty advocate of the use of the task-and-bonus system in practically all classes of work.

The idea back of task-and-bonus work is that an equitable bargain must be struck between the company and each employee. If the task is accomplished, the company will receive a definitely known minimum output at a lower total cost per piece than under the older wage-payment systems. In return for his effort to make the task which the company has set, the workman not only receives a reward which is large enough to make him wish to accomplish this amount of work, but also is guaranteed his hourly rate if he fails to reach the task. If he accomplishes the task, he is paid at his regular hourly rate for the time allowed for the task, plus a percentage of that time. This is equivalent to a high piece rate. Thus

¹Shop Management, Frederick W. Taylor, Harper & Bros., pp. 78-79.

the workman has all the advantages of day work on a task he does not meet and all the advantages of high piece rates if he is proficient. The basing of the high rate on a day wage, although it takes the form of a piece rate, allows different rates to be given different workmen, where this is desirable because of the varying lengths of their service, or differing all-round abilities. The task-and-bonus system is built up on the idea of the worker earning the bonus every time. This point is of some importance when considering the relative merits of this system and differential piece rates. Although task-and-bonus is theoretically presumed to be less severe on the workmen, yet in practice this may not be an important consideration, if the workers be trained to make their task and if the bonus be large.

Task-and-bonus work will fail unless the management has sufficient control of operations to insure that proper conditions for maximum output can be always maintained. Thus, not only must standards be set, but proper controls of purchasing, store-keeping, and planning must be fully established. This system is not one to use in a transition period.

The bonus, under the task-and-bonus system, will be determined by the individual concern in accordance with its particular needs. It will range from 20 to 50 per cent of the task rate. In order to understand the operation of this system, let us assume a case where the rate is 50 cents per hour, and the bonus is 20 per cent of the standard rate. If a workman completed a five-hour job in six hours, he would receive a day rate of six hours, or \$3 for the job, which is at the rate of \$4 per eight-hour day (if he continues the remainder of the day at the same pace). If he did the work in five hours, he would receive the day rate for five hours, plus 20 per cent of five hours, or a total wage of six hours, or \$3 for the job, which is at the rate of \$4.80 for the day (if he continued the remainder of the day at the same pace). If he did the work in four hours, he would still receive the day rate for five hours, plus 20 per cent of five hours, making \$3 for the job, or at the rate of \$6 per day (if he continued the remainder of the day at the same pace). The system is seen to be a day wage for substandard workers and a task rate for men who are standard or better. Many plants use a much higher bonus than 20 per cent. Thus the Lewis Manufacturing Co. of Walpole, Mass., manufacturers of gauze and like products, have utilized a 40 per cent bonus to urge the worker upward toward his task.

Two major advantages of any task system of wage payment, and particularly task-and-bonus, are its beneficial effects on cost predetermination, and hence quotations of selling price, and on scheduling work through the shop, and hence production control. It is in these respects that it differs most sharply from straight piece rates based on job study. In fact, were it not for these points, there would be no real difference between

task-and-bonus and the straight piece rate with guaranteed day rate. Under the latter system the guaranteed day rate is usually somewhat lower than the amount which can be earned on piece rate if the time set by job study be reached. There are thus several intermediate stages between the number of pieces equivalent to the day rate and the number equivalent to the standard. Under task-and-bonus there is no such condition. The day rate holds until the task is achieved, when there is a sharp jump in the wage, caused by the payment of the bonus. This sharp jump at the task point has the effect of causing the worker to reach the task practically every time. Thus it is possible to predetermine overhead costs, and use these predetermined overhead costs in developing standard costs. Furthermore the pull toward task time makes it possible to schedule and despatch operations in the shop with the assurance that machines will be available at stated times. Although five or ten minutes on one operation makes no difference in this matter, accumulations of such times over many jobs may readily disorganize a whole shop schedule.

The Curtis Publishing Company, of Philadelphia, has made a very successful adaptation of task-and-bonus to their factory operations and to allied work. The accompanying illustration (Fig. 99) shows one of their work tickets for their trucking division. The various runs which their trucks make to warehouses, freight stations, post-offices, etc., have been carefully studied and timed. Each run has been evaluated at a certain number of points, on the basis of 100 points for a fair day's work. As a driver finishes a run, his work ticket is punched, thus giving him current information as to whether he is ahead of or behind his task. For each of the first 5 points above 100 he receives 10 cents additional, and for each succeeding point 2 cents. The urge to reach the task and go slightly beyond is evident. This is made possible of accomplishment because the basis of 100 points is, in reality, based on the job studies, somewhat low, and a trucker should easily reach 102 or 103 points in making his standard task. Routes through uncrowded streets have been carefully mapped for him, and it is only under the most unusual conditions of bad weather that he is prevented from making 100 points or more through causes outside his control. All trucks are carefully governed as to speed to prevent violation of speed laws, and the savings come from attention to the job and rapid loading and unloading.

The Emerson efficiency wage. The system of graded bonuses first developed by Mr. Harrington Emerson is somewhat similar to the task-and-bonus system. The day wage is guaranteed, regardless of performance.* It differs in that bonuses are given to workers whose efficiency is less than 100 per cent, these being graded from the starting point up to 100 per cent, and in that efficiencies are not determined on a particular job, but over a pay period or longer. There is thus less of the drive on the

worker to make task time on each particular job, because if he falls a little behind on one job he can make up on the next. There is, furthermore, a gradual pull on the worker, and a worker who is 98 per cent efficient makes more nearly the wage of the 100 per cent man than under

TRUCKING DIVISION WORK TICKET											
TIME	POINTS					TIME	POINTS				
7.00	●	●	●	●	0		L	U	N	C	H
7.30	●	●	●	●	5	1.00	●	●	●	●	55
8.00	●	●	●	●	10	1.30	●	●	●	●	60
8.30	●	●	●	●	15	2.00	●	●	●	●	65
9.00	●	●	●	●	20	2.30	●	●	●	●	70
9.30	●	●	●	●	25	3.00	●	●	●	●	75
10.00	●	●	●	●	30	3.30	●	●	●	●	80
10.30	●	●	●	●	35	4.00	●	●	●	●	85
11.00	●	●	●	●	40	4.30	●	●	●	●	90
11.30	●	●	●	●	45	5.00	●	●	●	●	95
12.00	●	●	●	●	50	5.30	●	●	●	●	100
100 POINTS STANDARD DAYS WORK—Amounts Above Share in Savings											
105	○	○	○	○	.50	175	○	○	○	○	1.90
110	○	○	○	○	.60	180	○	○	○	○	2.00
115	○	○	○	○	.70	185	○	○	○	○	2.10
120	○	○	○	○	.80	190	○	○	○	○	2.20
125	○	○	○	○	.90	195	○	○	○	○	2.30
130	○	○	○	○	1.00	200	○	○	○	○	2.40
135	○	○	○	○	1.10	205	○	○	○	○	2.50
140	○	○	○	○	1.20	210	○	○	○	○	2.60
145	○	○	○	○	1.30	215	○	○	○	○	2.70
150	○	○	○	○	1.40	220	○	○	○	○	2.80
155	○	○	○	○	1.50	225	○	○	○	○	2.90
160	○	○	○	○	1.60	230	○	○	○	○	3.00
165	○	○	○	○	1.70	235	○	○	○	○	3.10
170	○	○	○	○	1.80	240	○	○	○	○	3.20

Courtesy Curtis Publishing Co.

FIG. 99.

the task-and-bonus system. Workers who are over 100 per cent efficient under the Emerson plan do not receive quite the wage of workers under the task-and-bonus system, for they receive their basic wage for the allowed

time, but their bonus (which is usually 20 per cent) is figured on the time actually worked rather than the allowed time.

The efficiencies are expressed in terms of a percentage. Thus, if in one period a worker has actually worked 96 hours and has done work for which the standard time is 84 hours, his efficiency is $87\frac{1}{2}$ per cent. If he has done work for which the standard time is 91.2 hours, his efficiency is 95 per cent. If he has done work for which the standard time is 105.6 hours, his efficiency is 110 per cent. A sample bonus table under the Emerson system is as follows:

Percentage of Efficiency	Percentage of Bonus	Percentage of Efficiency	Percentage of Bonus
67.00 to 71.09	0.25	89.40 to 90.49	10
71.10 to 73.09	0.5	90.50 to 91.49	11
73.10 to 75.09	1	91.50 to 92.49	12
75.70 to 78.29	2	92.50 to 93.49	13
78.30 to 80.39	3	93.50 to 94.49	14
80.40 to 82.29	4	94.50 to 95.49	15
82.30 to 83.89	5	95.50 to 96.49	16
83.90 to 85.39	6	96.50 to 97.49	17
85.40 to 86.79	7	97.50 to 98.49	18
86.80 to 88.09	8	98.50 to 99.49	19
88.10 to 89.39	9	99.50 to 100.00	20

On the basis of these bonuses, the wages earned by the worker whose base rate was 50 cents per hour under the percentages of efficiency indicated would be:

Per Cent of Efficiency	Base Rate	Bonus	Total Wage, Two Weeks
$87\frac{1}{2}$	\$48.00	\$3.84	\$51.84
95	48.00	7.20	55.20
110	52.80	9.60	62.40

Under the Emerson and similar systems of graded bonuses, there is less pulling power on the worker to make task time, with all its attendant management advantages. Since efficiencies are determined over a pay period, a worker cannot work at maximum pressure on one job, thereby making a very high rate, and then take things easy on the next job, with assurance of a good day wage. However, under task-and-bonus, disciplinary action will promptly eliminate any such program on the part of a worker.

	WAGE SYSTEMS NOT BASED ON JOB STUDY				WAGE SYSTEMS BASED ON JOB STUDY					
	Day Rate	Piece Rates without Job Study	Halsey	Rowan	Day Rates based on Production	Piece Rate	Differential Piece Rate	Task-and-Bonus	Emerson	Bedeaux
Guaranteed Day Rate	Yes	No	Yes	Yes	Yes	Possibly	No	Yes	Yes	Yes
Incentive for Worker to reach Maximum Productivity	No	Not Usually	Possibly	Possibly	Possibly	Yes	Yes	Yes	Yes	Yes
Maximum Spur to Best Possible Management	No	No	No	No	No	Possibly	Yes	Yes	No	Yes
Spur to Worker to reach Carefully Set Task	No	No	No	No	Possibly	Possibly	Yes	Yes	Somewhat	Yes
Payroll Computation	Easy	Fairly Easy	Difficult	Very Difficult	Easy	Fairly Easy	Fairly Easy	Fairly Easy	Very Difficult	Fairly Easy
Labor Cost Predetermination	Impossible	Easy	Difficult	Very Difficult	Fairly Easy	Easy	Fairly Easy	Easy	Difficult	Easy
Overhead Cost Predetermination	Impossible	Difficult	Difficult	Difficult	Difficult	Difficult	Fairly Easy	Fairly Easy	Difficult	Difficult
Quality Maintenance	Entirely dependent on character of product, methods of supervision and inspection, and other means taken to promote quality.									

FIG. 100.

The workman may be paid during a given period on the basis of his efficiency in the next preceding period, or on the basis of his efficiency in the period itself. In case he is paid on the basis of his efficiency in the next preceding period, he naturally gets all of his wages for the current period at the same time. If he is paid on the basis of his efficiency during the current period he will not receive his bonus wage with his regular pay envelope, as it will be necessary to figure the bonus wage prior to giving him his pay. It makes no real difference which way the wage is computed.

The Bedeaux-point system. This system is representative, and was perhaps the first, of a number of point systems, which provide a common denominator, man-minutes, to which human activity in all industries may be reduced. Percentages of fatigue, predetermined by class of job, are added to selected operation time to give task time. Task time is then represented by a number of "B's" equal to the number of man-minutes in the task time.

Base rates for each operation are set, expressed in terms of cents per hour. This affords basic comparison between operations. Wage earned is equal to the money value of the total number of "B's" produced. Day work and lost time that is not the fault of the worker is paid for at the rate of 60 "B's" per hour. The operator receives the base rate for each operation plus a fraction of that base rate expressed as "premium B's," or payment for the additional "B's" which he has done in that hour. If standard base rates are not reached, the operator nevertheless receives such rate for his performance. This amounts to a guaranteed day rate.

The chief contribution of such systems is that all work is broken down to common denominators, and hence comparison between departments or plants is simplified.

Beginning operators may be paid a rate below the standard base rate, and not advanced to the standard rate until, by maintaining a production of 60 "B's" per hour for several successive days, they have indicated that they are capable of earning the base rate that has been set.

The accompanying chart (Fig. 100) is a ready reference for comparison of the various wage-payment systems, and for information concerning their effect on various phases of operations.

CHAPTER XXVIII

SPECIAL FORMS OF WAGE PAYMENT

Group bonuses. When the nature of the task requires that workers be formed into groups, the members of which are dependent on one another as regards output, some form of group bonus usually proves most practicable. This plan has also been used successfully by putting the entire personnel of a department on group bonus, although their work is not directly related. Any of the incentive types of wage payment can be used in group bonus, or group incentive, development.

The paramount advantage of group bonus is that it promotes teamwork in that group to which the bonus is applied. However, since but one premium or bonus need be figured for each group involved, the amount of clerical labor is reduced somewhat. It also may be used to reward foremen and other supervisors by including them in the group or departmental unit that is subject to the bonus. It is simple for the management to check the efficiency of groups, departments, and the plant as a whole from day to day. No complicated statistics are necessary, but merely a review of a few time tickets. Indirect workers, even sweepers and janitors, may be brought to have cost reduction within their department as their primary goal. The co-operation of all workers is enlisted in bringing up substandard workers.

At the A. O. Smith Corporation, Milwaukee,¹ the factory is divided into divisions, and the divisions into groups. A group may have any number of men working on a given number of machines, performing such operations as are allotted to these machines by the factory routing. Each operation, on a part passing through a group, has a time study taken, and the total time of the combined operations in a group constitutes the standard time of that part, for the group. Any number or kind of parts may pass through the same group, just so long as each part has a standard time.

No clocking in or out is necessary for the various kinds of parts. The only time check necessary for a worker is that he punch "in" in the morning, and "out" at night. He is not required to leave his department at any other time. There are no job tickets or coupons for him to make out. He may begin an operation where a night man left off, with-

¹ The Society of Industrial Engineers Bulletin, Vol. 9, Nos. 5-6.



out any check except that he be identified with the group in which he belongs.

The group is credited with the number of finished parts that have passed inspection, at the end of the division, at which point a count is taken—usually of an assembly or of a sub-assembly. The total standard time multiplied by the number of pieces constitutes the standard hours credited to a group. The total standard hours for a pay period, divided by the total actual hours of the group, is the percentage of group efficiency due each member of the group. By referring to a group bonus table, anyone can easily figure his earnings.

The time department issues a daily statement to each group, so that the various group members know what their earnings are from day to day.

Mr. George L. Mueller, Divisional Superintendent of this company, feels that the special advantages of the group bonus to the company include the following:

The in-process inventory is greatly reduced because several operators can be working on the same lot at the same time. The floor around the machinery is not clogged with partly finished material waiting to be checked or moved.

The workers of a group force the material over their line to the next group and so on through a division, because they are not paid officially for any parts until the final check or count is made. This automatic flow of material cuts out the factory stock chasers; cuts down on the trucking, in and about the machinery; it allows more floor space by moving machinery closer together, and thereby makes a department more efficient.

More accurate promises of shipments can be made to customers, as all material flows through the factory according to schedule and material does not get "lost" nor thrown aside. All that is necessary is to start a part through a group and the group will see that they get their credit by forcing the part through the division.

The "neck-of-the-bottle" operation receives the most attention from the group itself. It is a fact that wherever there is a constant "hold up" operation, in lone production, the "group bonus" plan will always speed this point up to the capacity of the balance of the line. The slow operations are assigned to the fastest men in the group, and thus all the help necessary is given to get the maximum production. There are "tricks of the trade" to every operation, and with several workmen on the "firing line" the best and fastest methods are worked out in very short time, by the group members.

The patent advantages of group bonuses have led to their use under conditions to which they are unsuited. If the jobs are entirely unrelated, it may be that the spurring action of one employee on another will not be

as effective as anticipated, and under such conditions poor operators will profit from the better-than-normal work of the best workers. Furthermore, under some conditions the best workers will feel that an unfair advantage has been taken of them by figuring their wages partly on the efforts of inferior workmen. Therefore, although group bonuses will always work to advantage when a given operation is performed by several workers, whose individual efforts are inseparable for wage-payment purposes, they will not always succeed when applied to whole departments. In such cases, individual day rates will have to be set in any case, and the bonus for each worker will be a similar percentage of his day rate, but a different amount. It is probable that the relative ease of setting bonuses by groups will not compensate for the inaccuracies which occur. Bonuses under such conditions might better be paid on an individual basis.

Among the disadvantages of group bonus is the possible severity of the arrangement. The fact that some workers receive wages which are partly based on the output of others engenders ill-feeling and back-biting under bad conditions. Rate-cutting is just as easy with group bonus as with any other type of wage payment. If the management feels that the men are making too much money, non-productive workers, such as sweepers, can be added to the group, with the explanation that "the management had not included him through oversight and that he really was a part of the group at all times."

Group bonus, because it makes one worker desire to help another, results in developing all-round men. This is of importance at times when production must be decreased, for, by reducing the number of men in the group, production is automatically cut.

Foremen's bonuses. In group bonuses, the salaries of the foreman and his assistants are added to a departmental payroll, and foremen receive their bonuses as a part of the group division. Therefore, the bonus that a foreman receives is directly proportional to the productivity of his department. This is an essential feature of any foremen's bonus scheme. In the Bedeaux system it is easy to determine the number of "B's" produced by a department, and to give the foreman a bonus based on a previously determined scale. Under the task-and-bonus scheme a foreman may receive a bonus based on the number of workers under him who are themselves receiving bonuses.

One still meets frequently in industry the foreman who hesitates to teach the workers under him for fear that one of them may learn as much as he knows and thus secure his job. The payment of production bonuses to foremen is, in a sense, additional payment for teaching the workers all that they can. The foreman also becomes directly concerned with the removal of all obstacles toward increased production, instead of leaving this to the higher executives or to the methods men.

Foremen's bonuses can be worked out for any phase of the operation of their departments, as, for instance, quality, or accident reduction. Foremen's bonuses for accident reduction were more frequently used in the early days of the safety movement, in order to interest foremen in safety. Very effective results were secured at that time by foremen's bonuses.

ACCIDENT FREQUENCY RATES PER 1000 WORKERS *

	1912	1913	1914	1915	1916	1917
Bonus plants	179	102	36	45	36	36
Non-bonus plants	186	173	107	98	130	90

* Monthly Labor Review, U. S. Dept. of Labor, Bureau of Labor Statistics, Sept. 1919, p. 272.

(Blast furnaces, steel works, and rolling mills are included in both the figures for the bonus plants and for the non-bonus plants.)

At the present time, when most foremen have been "sold" on safety and recognize accident prevention as one of the most important parts of their jobs, there is less tendency to give monetary rewards for accident reduction, and a greater tendency toward the giving of cups to the department (see Chapter XV) and other non-monetary rewards.

Quality bonuses. In considering incentive wage systems the question is constantly asked, "Do not such systems tend to increase quantity of production at the expense of quality?" At times, in actual usage, there seems to be so much stress on securing maximum quantity of production that quality cannot help but suffer. This has caused manufacturers producing a quality product to hesitate to use such systems, particularly to turn to them from the day rate. There are two general remedies which can be applied to this situation that will help keep up quality equally with quantity while the worker is trying to earn his premium or bonus wage. The first of these remedies is to insure stringency of inspection; the second is to utilize some sort of a quality wage bonus.

If strict inspection standards are maintained and the workers know that quality must also be a result of their efforts or material will be returned to them for reworking or they will be otherwise penalized, quality will usually be maintained. In the usual type of work a proper inspection system will ordinarily prove to be sufficient inducement to secure quality. Bonuses for quality are more frequently found only where quality, not quantity, is of paramount importance, though they are also used at times where quantity is also desired. The Joseph & Feiss Company uses a quality bonus of 15 per cent of the production wage on some operations.

This can be earned without the production bonus, but the latter cannot be earned unless the quality be standard.

Action by the inspection force of a plant has the negative effect of penalizing the worker. Quality-bonus systems operate in the opposite way. They are positive inducements toward better quality and pay the worker for quality instead of merely penalizing him for lack of quality. Quality bonuses may be used with any wage system that has been discussed. In some cases they may form the only type of incentive wage that is used. It will thus be observed that quality bonuses divide themselves into two classes, (1) those which are utilized where quantity bonuses are impossible, or at least impractical, and (2) that type or quality bonus which is used in conjunction with some form of quantity bonus to make a composite wage system in which the pull on the worker will be both toward quantity and quality.

Methods of utilizing quality bonuses, where they represent the only type of incentive wage in effect, will be best described by illustrations. One type of work which is best put on an incentive basis by the use of quality bonuses is inspection work. It would be manifestly hard to pay inspectors in accordance with the amount of work they might turn out. This would be conceivably possible, as, for instance, a payment in accordance with the number of defects discovered. Such a system of payment would, however, largely be dependent on the skill of the worker rather than of the inspector and would also probably result in considerable argument between the workers and the inspectors as to whether or not work were up to standard. A better system is to over-inspect the inspector's work. That is, to have chief inspectors who will test sample lots of material that have already passed through the hands of the regular inspection force. Bonuses can then be paid on the basis of the perfection of inspection that the inspectors have achieved. Such a plan is entirely feasible on any inspection job, but is unquestionably more feasible in cases where a large amount of similar material passes through the hands of the inspectors constantly.

Another illustration which will indicate the manner in which quality bonuses operate will be a rather elaborate one describing the quality bonus system used in the plant of the Nashua Gummed and Coated Paper Co., Nashua, N.H. This plan is particularly noteworthy because of the number of peculiar features which are involved in the bonus system. It shows to what extent the payment of bonuses can profitably be carried, and indicates that the bonus idea can be applied to almost any kind of a job. This bonus plan has been developed in the color-mixing room of this plant, where quality is more essential than quantity, where all the work is essentially group work, and where the workers each perform more than one job in a working day. Such a situation involves about as many

complicating situations as could be found in the ordinary plant, and many managers would have hesitated to try anything but day work under such conditions.

In this mixing room there are four men working, one of whom is practically in charge, though he is a leader rather than a foreman. The work of these men is interdependent, and they must perform during the course of the day four general types of jobs, each of which must come up to a quality standard that has been set. These jobs, are, (1) preparation of color mixtures, (2) keeping cans of mixed colors in condition for immediate use, (3) filling mixers in the coating room where the colored coating is applied to the paper, and (4) cleaning the "monitors," or mixers.

The group of four men is paid one basic day wage, which is divided among them in percentage based on their experience, rather than the actual work which each of them does, as this latter cannot be determined. If all of the four jobs above mentioned are satisfactorily performed the gang receives a stipulated bonus for that day which is also divided among them in the same proportions as the day wage. If inspection of the work that they perform on a certain day indicates that one of the four jobs has not been satisfactorily performed, one-quarter of the day's bonus is deducted. If two of the four jobs have not been satisfactorily performed one-half the possible bonus is deducted; if three of the jobs prove unsatisfactory, three-quarters of the bonus is deducted; and if none of the jobs are up to standard, the workers receive no bonus, but only the day wage for that day.

It will be well to indicate what the basis of inspection on such jobs can be. On job (1) the principal basis of inspection is the percentage of moisture in the mix. A variation of 2 per cent of moisture is allowed without loss of bonus, but beyond that percentage of error, the bonus is lost. Thus if the correct percentage of moisture on a given job were 50, if the moisture were found upon inspection to be 49 or 51 per cent, the bonus would be made. If the moisture were found to be 48 or 52 per cent the bonus would be lost. On job (2) the test is largely one of appearance, for the trained man can quickly determine whether or not the color has been kept properly stirred, and hence in condition for immediate use. This task is a necessary one, inasmuch as the colors sometimes remain mixed for some days prior to use, and will deteriorate unless properly stirred. On job (3) the test is whether or not the mixers in the coating room are kept filled up to a certain stipulated number of gallons at all times and whether orders have been withdrawn without wastage. The purpose of this bonus is to prevent stoppages on the coating machines because of the lack of available color. On job (4) the condition of the machines is inspected as being "good" or "bad." This is, of course, based on the judgment of the inspector, but it is a job on which the bonus can be easily earned. The inspection work described is not caused by utilizing the

quality bonus. It would have to be carried on in any case and experience has indicated that it is made easier through the utilization of the bonus.

This illustration serves very well to show how quality bonuses may be paid without reference to quantity of production and indicates the types of jobs which lend themselves to the payment of quality bonuses. It is equally easy to combine the payment of quality bonuses with bonuses for quantity. The combining of such bonuses will prove an immediate check on rapid increase of production without regard to quality. Thus, in the weaving of cloth, a bonus may be paid on the production which is secured from the loom, while another bonus may be paid if the defects which are discovered in a certain number of yards of cloth are kept below a certain number. The relative amount of bonus to be paid for quantity and quality will vary with the importance of quality in the particular instance, as for example, the value per yard of the finished fabric.

One type of work on which great success has been secured through a combination of quantity and quality bonuses is typing work in large offices. Very successful task-and-bonus schemes have been based on the number of lines of output per hour, or the number of square inches of typing per hour which are produced. Of course, the number of mistakes which are made by the typist will have a very distinct effect on the value of the work. Therefore, quality bonuses have been devised which pay the typists extra wages in case the number of mistakes in a specified number of lines or square inches of work is held below a stipulated amount.

A combination inspection system and quality bonus has been devised which is known as the "Debit and Credit Bonus." This is used on processes which involve a number of very short operations, as in some of the needle trades, where the cost of inspection after each operation would be prohibitive. Under this system each operator forms a check on all preceding operators for the quality of their work done. If she discovers a defect in quality she reports it to the foreman and receives a stipulated bonus for so doing, which is charged against the worker making the error. It is an automatic inspection scheme which is very harsh in its application, but which frequently has proved very effective in bringing up quality on short operations.

Bonuses based on amount of equipment in operation. A type of quality bonus may be developed to reward those whose tasks are directly related to keeping equipment in operation. The work of such persons is so varied that it is difficult to set predetermined tasks, but it is possible to base bonuses for the whole group in percentages of equipment in operation. Thus the Aberfoyle Manufacturing Company, of Chester, Pa., gives bonuses to its loom fixers and smash fixers based on the number of looms in operation as follows:

- 5 per cent—1100 looms in operation.
- 10 per cent—1200 looms in operation.
- 15 per cent—1275 looms in operation.

This particular company extends this bonus to include persons on previous operations, on the basis that it is the prompt accomplishment of their work which helps make possible the operation of the number of looms in question. The dyeing room and beaming room thus share in bonuses based on the number of looms operating. It is evident that the basis of such bonuses must change from time to time as operating conditions change.

Attendance bonuses. The next general type of special bonuses to be considered may be termed "attendance" bonuses. These are special bonuses paid for perfect attendance or a percentage of attendance up to a specified standard. Attendance bonuses may be for attendance only or may include extra payment for promptness, or the payment for promptness may be the only type of attendance bonus granted. Bonuses of this type are frequently paid in money, but are often paid in the form of vacation or added days on vacation. If paid in money the amount is not usually very large. If paid in vacations, a basis that is frequently used is one day's vacation (or extra vacation if the factory is already on a vacation basis) for each month of perfect attendance.

Attendance bonuses are of great value in increasing output since they aid continuity of attendance on the part of the working force, thus insuring that any production program that is mapped out will not be hindered by lack of personnel to carry it through. The promptness bonus is particularly advantageous in this respect, inasmuch as it usually results in almost uniformly prompt attendance throughout the factory. This enables the production department to know, soon after the factory doors open, what vacancies in the factory force must be filled in a given department on that day, in order that production may be kept flowing smoothly and up to schedule.

There is one element in attendance bonus payment that is not altogether pleasing to a large number of plant executives. That is, that the payment of such bonuses results in the duplicate payment for something that the factory is already paying for. It is claimed that when a person is engaged he is expected to be at the factory on all working days and to be there promptly. Therefore, an attendance bonus should be unnecessary and is a payment which is undesirable. This argument has much strength in theory, but the facts of experience have indicated that a small attendance bonus is an expenditure well made, as it most distinctly does serve to bring in the workers on time every working day and also decreases the days "out." In times of slack production attendance bonuses are likely to be quickly eliminated.

Length of service bonuses. One criticism that is to be found in paying all men on a given job the same rate of pay, or pay varying only as their production varies, is that it does not take account of the length of time that the worker has been with the company, his loyalty, general knowledge of plant conditions, and ability to do more than one type of work. Some plants give workers of long service higher base rates for similar work than newer workers. The Palmolive Company has combined variable hourly rates, based on length of service, with piece rates. A certain number of units, or pieces, is set as an hour's task. Different workers are paid different rates per hour, based on length of service and ability to do more than one job, but their wage is determined by the units set for a given job. An interesting advantage of this method is that the task, being set on units per hour, is expressed in the same terms for every worker, regardless of their individual base rate.

Some plants have paid for long service by bonus, rather than by either of the methods just described. This bonus, usually a percentage of earnings, is paid regardless of the type of work which is performed or money earned in a given period, and it increases as the length of service increases. Some plants have begun the payment of service bonuses as soon as six months after the employee has entered the employ of the concern, while many have deferred the payment for as long periods as five years. The basis of this payment will depend on the type of worker that the company desires to reach, and also on the length of service that is necessary to make the employee really of extra value from a producing standpoint.

Overtime or odd-shift bonuses. Payment for night and Sunday work, as well as for overtime work, is frequently made on a bonus basis. The familiar "time and a half for overtime" is not the only method of paying for this type of work, although it is more common for overtime work than it is for night or Sunday work. Some of the plans for payment of bonus for night-shift work are as follows: (1) payment of a certain stipulated number of hours pay per week in addition to the pay for the number of hours actually worked on the night shift, e.g., payment for three or five extra hours, (2) payment of a bonus of a certain number of cents per hour worked on the night shift, as 2 cents or 5 cents per hour, (3) payment of a certain percentage of the day rate in addition to the day rate for night work, as 10 per cent or 15 per cent. The increase of the base rate for night work need in no way affect the operation of an incentive wage system, as the premium or bonus can be figured out on the night base rate as easily as it can be figured out on the day base rate. A study of the methods of payment of overtime to hourly and piece workers of 22 plants is analyzed in the accompanying table (Fig. 101).

Payment of salesmen. There is no one type of payment for salesmen that will fit all cases. Straight salary has been paid less frequently as the

same elements that make for inefficiency under the day rate have been seen, under newer sales conditions, to apply to salesmen under straight salary. For the same reason that piece rates, without guaranteed day rates, are ineffective, any commission or bonus plan is usually coupled with a basic salary or drawing account. Commission over straight salary is paid for sales above a minimum quota that has been set, and in the case of drawing accounts, these are paid back by the salesman through commissions earned, after which all commissions earned are his. Many firms give salesmen bonuses for unusually good performance.

Basic salaries can be determined on the basis of the salesman's past worth to the company plus his knowledge of the company's products, and with regard to the type of customer with whom he is dealing. Commissions vary with the extent to which sales price exceeds cost, and with the total of goods sold.

Straight salary payment leaves a company free to transfer a salesman to any part of its territory, and commission encourages overselling to the neglect of service, especially for salesmen who do not expect to stay with a company for a long time. Nevertheless, most good salesmen desire to be paid directly in accordance with the results which they achieve, and some form of commission is almost universally used.

Executives' salaries. Job study of executives' work is almost solely for the purpose of setting salaries. Little can be done through job study in the development of executive methods. While the detailed character of an executive job has little relation to the proper salary to be paid, yet there is much to be gained in large companies through the development of a salary scale for executives based on some of the fundamental characteristics of the several jobs and of the character of the men who are necessary to fill them.

Among the factors that may be taken into account in setting a scale for executives' salaries are the following: education necessary; amount of business experience necessary; amount of specialized business experience necessary; amount of administrative experience necessary; number of workers supervised; character of workers supervised; and amount of payroll supervised. A table fitting the needs of a particular business can be worked out, with ranges of salary within each step of the table set. Then the salary of an executive whose duties and qualifications come within any step of the table is set on the basis of the salary specified in the table. Changes in payroll affecting executives must usually be studied and approved by one of the major operating officials of the company, and not by rate-setting or similar groups.

OVERTIME PAYMENT OF

Firm Number	What per cent of production workers are paid on.		How pay hourly rate workers for			Is the extra wage increased as overtime increases?	How do you pay piece workers for.			Is overtime payment controlled by union rules?
	Hourly Rate	Incentive Rate	Overtime	Sun-day	Holi-day		Overtime	Sun-day	Holi-day	
1	None	All	1½	2	2	No	P.R.	P.R.	P.R.	No
2	16%	84%	1½	1½	1½	No	P.R.	P.R.	P.R.	No
3	18%	82%	1½	No overtime		No	Overtime = P.W. plus ½ D.R.			No
4	20%	80%	1½	1½	1½	No	1½	1½	1½	Open shop
5		78%	1½	1½	1½		1½	1½	1½	No
6	25%	75%	1	1½	1½	No	P.R.	P.R.	P.R.	No
7	25%	75%	1½	1½	1½	No	P.R. earnings plus ½ day rate			No
8	27%	73%	1½	2	2	No	Earnings plus ½ H.R. or regular H.R.			No
9	30%	70%	1½	1½	1½		Bonus earned plus 1½ hourly rate			Open shop
10	33%	67%	1½	1½	1½	No	Overtime get 10% additional			No
11	66%	34%	Nothing extra			No	Straight time plus incentive			No
12	49%	51%	1½	2	2	No	1½	2	2	No
13	50%	50%	1½	1½	1½	No	P.W. plus ½ or 1 hourly rate			No
14	50%	50%	1½	2	2	No	1½ time of hourly rate			No
15	60%	40%	Usually time and one-half			No	P.W. plus ½ hourly rate			No Company schedule
16	60%	40%	1½	1½	1½	No	Average plus 50%			Very rare cases
17	80%	20%	1½	1½	1½	½ time at earned rate per hour	1½	1½	1½	Open shop
18	100%		1½	1½	1½	No				No
19			1½	1½	1½	Time and half after midnight	Nothing extra			No
20	100%		1½	2	2	No				No
21	10%	90%	Straight time or 1½			No	Straight earnings			No
22	92%	8%	1½	2	2	No	P.R.	P.R.	P.R.	No

NOTE: ½ = time and one-half; 2 = double time, P.R. = piece rate;

FIG.

HOURLY AND PIECE WORKERS

Are allowances made to piece workers for delays for which they are not responsible?	How are piece workers paid who are working overtime through some failure of their own?	How are piece workers paid who are working overtime because of break-downs or causes over which they have no control?	Do records show that efficiency decreases as the amount of overtime increases?	Pay a bonus for night shift work?	Pay any extra bonus or wage for overtime on Sundays or Holidays?
Yes	Not paid for time on spoiled work	Piece rate	Yes	We have none	Regular overtime rates
No	Regular rates	Regular rates	Not enough overtime to tell	No	Time and one-half
Yes	Regular rates	Regular rates	Positively	No occasion for night shift	Would pay time and one-half
Employees paid hourly rate plus bonus earned			Not much overtime	Same as day	No extra bonus 1½ time plus bonus earned
Yes	Regular rates	Regular rates		6-hour shifts get 20% bonus	
Yes	Regular rates	Regular rates	Not enough overtime to tell	15% bonus for certain classes	No
Day rate	This condition does not exist	Piece work plus half day rate	No records	10% over amount of wages earned	Day worker 1½ P.W. earnings plus ½ day rate
Yes	Regular rates	Regular overtime rates	Have no records, but think so	Yes	Sundays and Holidays plus hourly rate
Base hourly rate	10% additional	10% additional	Depends on individual	10% over day rates	No
Yes	Straight time	Straight time plus incentive	Insufficient experience	No	No
Not usually	Regular overtime schedule	Regular overtime schedule	Not as efficient	Yes, 5%	Regular overtime schedule
Straight hourly rate	Do not have this condition	Piece rate plus ½ and 1 hourly rate	Not enough overtime to tell	No	No
Regular day rate	1½ time of hourly rate	1½ time of hourly rate	No records, but efficiency decreases	10% of total earnings	Overtime rates
Usually transferred	No additional pay allowed	Piece work plus one-half hourly rate	No record	No	Half hourly rate plus piece work earnings
Yes	Same as others	Time and one-half	Yes	Amounts to 36% bonus	Not beyond usual time and a half
Yes	Situation does not exist	Time and half at day rate	Very little overtime worked	No	No
			Yes	No, use rotation system	No
Paid on hourly basis		Regular rates	No records	Have not any night shift	
			No records	Hourly increased about 20%	No, only double time
Yes	Straight earnings	Straight earnings	No record	No	No
Not usually	Piece rate	Piece rate	No records	No	No; double time

P.W. = piece work; H.R. = hourly rate.

PART VII

PERSONNEL RELATIONS

CHAPTER XXIX

THE PERSONNEL POLICY

THE extent of plant morale may best be measured by the degree of co-operation that is extended to the management by the workers during the ordinary routine of operations. This co-operation is not always achieved entirely through the payment of high wages, through extensive service work, or even through participation in the management by the employees. All of these factors will be found to influence it; yet in many plants where numerous steps have been taken toward bettering these phases of management, success has not been achieved in building a morale equal to that of other plants wherein these phases have received but little thought. Under older types of management, morale was frequently unconsciously developed to a higher degree. Under newer types, success in creating morale has frequently not been large, despite conscious efforts in that direction, after many other "betterments" in management method. Such instances are caused by lack of confidence in the management on the part of the employees. They incline to be the exceptions to the rule, because newer management refuses to accept as either inherent or necessary an attitude of disinterestedness on the part of the workers. Under older management methods, where morale had not happened to develop, such a condition was taken as a matter of course. To-day every effort is being made in far-seeing organizations to create and arouse the interest of the worker in his work. If these attempts are successful, many of management's most vexing problems will be solved.

Mr. J. M. Larkin, Assistant to President, Bethlehem Steel Company, has said, "The average worker in the main wants five things: (1) a steady job; (2) adequate real wages; (3) a good supervisor; (4) an individual and collective voice about all of his conditions; (5) a chance to rise on his merits." To provide these there must be a personnel policy which fundamentally looks into the minds of the workers, finds what they are thinking about, and from this and good common sense management lays down a

barrage of understanding that makes for good employer-employee relations.

It was some years before industry, in its period of great expansion, realized that the contacts between employer and employee which existed when companies were small had disappeared. With the growth of attention to personnel policies has come the realization that the company has new and wider responsibilities that the old employer never had. Much of our social fabric in this highly industrialized age depends on a large degree of satisfactory personnel relations in our industries. Plants that are attempting to create and maintain morale among their workers try not only to maintain a stable working force, but to arouse in the minds of individual workers the conviction that their jobs are important, and that they are important members of the industrial community. All phases of modern management assist in this. Thus, the setting of exact tasks for a worker raises rather than lowers his morale, inasmuch as it gives him a buoy to steer by; while the development of an incentive wage system, being a means of recognizing merit in a worker, indicates to him the importance of performing his tasks as expeditiously as possible. It is the development of such points of view in the workers' minds, quite as much as the material rewards involved, that make for success.

Development of the creative spirit of the worker. The development of the workers' creative spirit is, over long periods of time, one of the most successful means of raising plant morale. We all have the desire to make something, to see the results of our labor. If those who direct the workers' effort will take this into account, his co-operation is likely to be assured. Although the shoe-worker of to-day cannot make the whole shoe, he can be allowed to see and perceive what he is doing. The desire of mankind to express initiative or creative spirit has frequently been misinterpreted to mean that workers desire a share in the management of industry. Careful analysis has revealed that, regardless of participation plans, the co-operation of workers is best assured when they recognize their part in the whole process of production, and understand thoroughly the operation of their own department and the organization as a whole. Effective instruction of the workman, rather than allowing him to "pick up" his job, is one of the most vital forces in this direction. The finely subdivided tasks of modern industry, and the highly repetitive work frequently involved, challenge management to find methods to allow the workers' creative spirit to develop. Modern management methods may be used to repress the employee or to allow his fuller development. It is the task of management to insure that the latter result is achieved. If this phase of the worker's energy be not guided into constructive channels, it is very likely to seek for itself destructive ones. Thus the worker who day after day is kept at the bench on a repetitive task, and who sees

paper forms regulating what work he shall do and when he shall do it, is likely to build up a fairly solid aversion to the forms. But if the operation of the controls which they represent is explained to him, if he is shown how they enable the management to insure proper processing and filling of orders on time, and if he has the opportunity to see and understand the charts which correlate the information on his and others' time tickets, not only will he begin to see the spirit of the game, but he will make suggestions to improve the way it is played. The development of such spirit and co-operation in the worker implies a high caliber of foremanship, and it also implies that some portion of the management has it constantly in mind as its primary objective.

The field of the personnel department. Plant morale is so intangible and its development so difficult that it was not until the growth of the personnel department in industry that most concerns paid any conscious attention to it. Many personnel departments, mechanistically conceived, have gone about the various phases of their work without seeing their relationships to this most vital factor. The personnel department that has for its object only the hiring of the worker, his training, and the supervision of the workers' activities that do not deal directly with production, has not begun to visualize its task. This department must take the productive process as it finds it, and develop, with the aid and co-operation of the production executives, this intangible thing, plant morale. It must seek ways and means of looking at the plant through the eyes of the worker, in order that it may take steps to eliminate, either directly or with the co-operation of the general and production management, those factors which are the cause of the failure of the workers to co-operate.

The personnel department is that section of an organization that can be continuously looking at operations from the viewpoint of the worker. And, regardless, of its own particular method of organization, this is its primary reason for being. To organize a personnel department does not imply that line executives may cease to think of the workers' point of view. It merely means that there is in the organization a department which will now continually bring the workers' point of view to the line executives. Neither does the creation of a personnel department relieve the general management of the necessity of considering major policies with the workers' point of view in mind. No personnel policy will succeed which does not have the original and continuous backing of the general management. But details of operation, rather than broad considerations of policy, may frequently absorb the time of the general management. It is the function of the personnel manager to keep the general management in constant touch with the pulse of the workers, and to guide them toward decisions which will make for whole-hearted co-operation of the workers. The personnel manager should be in such constant touch with

the worker that he may readily interpret for the general management pulse-readings which are abnormal, but which might to them seem normal. In other words, it is the one basic function of the personnel department to develop and adhere to a long-run policy which will create and maintain good-will on the part of the employees toward the management and the employer. All minor portions of personnel policy are dependent on this fundamental, and it is the task of the personnel manager to see that the operations of the busily engaged line executives do not interfere with the growth of the good-will of the employees toward the concern. This is true regardless of the title or announced scope of authority of whosoever may be in charge of personnel work, and regardless of how much detailed personnel administrative routine must be carried on by that person. It is a task of the personnel department to prove to the worker that he is not a cog in the machinery of production, but rather a vital section of the machine, regardless of how small his share in the productive process may seem to be.

There are some fundamental points of contact in the relationship of the firm and the employee that the personnel manager must continually have in mind if he is to prove successful in the development of his personnel program on the basis just outlined. Among these are security of employment, hours, wages, and working conditions. If these factors, which come directly in his province to discuss with the general management, are soundly developed, he will find it relatively simple to carry on the more routine expressions of the personnel policy. The importance of security of employment is particularly likely to be lost upon the line executives, as they analyze production and sales schedules, or as they consider cost reports. There is hardly anything of greater importance in developing the interest, confidence, and good-will of the employee than security of employment. Restriction of output and other hindrances to production programs on the part of the workers generally may be found to rest on a fear that they will suffer unemployment if they adopt any other program. The personnel manager should therefore make the key-stone of his program constant vigilance that this is the program of the operating executives.

Operation programs that do not provide for this factor he should criticize severely and continually, and it should be his task thereby to keep the attention of the major executives focused on the effect of their decisions on the long-run labor policy. In all matters affecting hours, wages, or working conditions, which are fundamental in making the plant a good place to work, he should not only be consulted, but his advice should weigh heavily in the final decision.

The most effective way in which the personnel manager and his department may assure the worker of their interest, and that of the firm as a

whole, in his problems, is an intangible one—their general attitude. To secure the co-operation of the workers on the basis of such an attitude is a gradual achievement and one that is gained through effective handling of particular situations. There are many ways for a personnel department to work toward this aim, but, regardless of particular ways which may be described, the most effective methods will occur to the personnel staff at particular times and under particular conditions. One primary step is to provide for the hearing of any complaints with reference to wages, treatment, or conditions, to investigate these complaints, and to endeavor to adjust them and prevent their recurrence. Although it is a fundamental that the personnel department shall thoroughly understand and be sympathetic with the employee, in this relationship they must not forget their obligations to the production forces nor the requirements of production. Unless they continually keep these in mind, they will shortly become an outlaw group in the minds of those executives who are continuously faced with production difficulties.

The plant publication. One of the most successful ways of developing and maintaining the right basic personnel policy is through the plant publication. Such an organ will thoroughly acquaint the employees with each other and with the management, and it may be readily utilized as a means of expressing the fundamental concepts of the employer and the management, and frequently, what the workers are thinking as well. The plant paper is particularly valuable in this connection in organizations whose units are widely scattered, although its value is by no means limited to such cases. Of course, there have been many plant papers published which have made no attempt to cover labor policy and have been put out merely with the hope of, in some general way, increasing the good-will of the employees. While these are usually valuable, it is to be regretted that they do not further make themselves useful by considering the labor policy. Not much space is needed for this, and the large majority of the space in the magazine may still be used for educational, inspirational, and local-comment material. However, in order to form a background for the basic personnel policy of the plant, it is necessary that the plant paper be well edited, and of real interest to the employees.

The proper position of the firm in the life of the employee. One of the phases of personnel policy on which there can be much honest disagreement is the position of the company in the life of the employee. Paternalistic concepts of the employer-employee relationship cannot help but destroy morale, and yet the personnel department must stand ready to co-operate with any outside interests, municipal or private, which may be taking steps toward general betterment of social conditions within the community. It is a peculiar fact that the more the personnel department works with problems of morale development, the more likely it is to extend

into paths and methods of activity which lead in the direction of paternalism. The type of work within the plant and within the community which has the greatest possibilities of the development of industrial goodwill has also the greatest possibilities of paternalism.

Some plants, located in communities which are unable to provide amusement for their citizens because of their size or remoteness, frequently find it necessary to provide living and recreational facilities for their employees in a manner which may smack of paternalism. This may not prove pernicious, provided it is properly handled. What must be avoided are plans which indicate that the company feels it controls the entire life of the worker, merely because it is his employer.

CHAPTER XXX

THE EMPLOYMENT DEPARTMENT

The development of the employment department idea. Through the need for better understanding between employer and employed, through the increasing complexity of modern industry, and through the growth of the functional and staff ideas, the employment department in industry has developed. It undertakes one of the most fundamental of personnel functions, securing and maintaining an adequate personnel for operations. This department had its inception in conditions which had grown up through the continued presence of large masses of floating labor in American industry. For years, with the supply and adjustment of labor left to the superintendent, foremen, and other department heads, thoroughly taken up with the performance of their line functions, there had developed a condition of hiring and firing and a cycle of coming and going, with little thought of the consequences.

Although these conditions did not develop overnight, a realization of the desirability for their elimination did. It was not until the attention of managements, the country over, was forcibly drawn to the dollars-and-cents losses involved in high labor turnover that steps on a large scale were taken toward placing the hiring and maintaining of the working force on a sounder basis. One of the pioneers in this was Mr. Magnus Alexander,¹ then of the General Electric Company plant, at Lynn, Massachusetts. In a series of forceful addresses throughout the country, during 1914 and 1915, he hammered home to the business community the expenses incident to continued replacement of working forces. His figures were based on a study which he had made. He pointed out that firms changed personnel from one to three times a year, and explained that this meant a loss of from \$8 to \$200 for each man hired. This loss he carefully measured under various headings, such as direct costs of hiring, instruction in the jobs, increased wear and tear on equipment, increase of spoilage, and decrease of output.² His studies and those of others aroused unparalleled interest throughout industry, and plants which had developed employment departments were constantly importuned to describe their methods of operation. Although it was quickly recognized by all that

¹ President, National Industrial Conference Board.

² See *Annals of American Academy of Political and Social Science*, May, 1915.

much of the turnover was due to unavoidable separation, yet most of it seemed to be traceable to causes that were preventable.

Plants that had centralized in a functionalized employment department the hiring and maintaining of the working force seemed to have lower turnover figures than those that had left these phases of operation in the hands of the foremen and other department heads. There quickly developed a scramble to organize employment departments and to give these departments control over many phases of personnel work which were not directly concerned with the employment function. Frequently, because of the haste in organization, the right man and the right methods were not found, with the usual disastrous results of haste. However, the employment department idea came not only to stay but to grow, and every subsequent analysis of labor-turnover figures for groups of plants indicated that those plants with the most highly developed employment and personnel work had the lowest turnover records. Thus, in an analysis made by the United States Bureau of Labor Statistics in 1918, it was found that even under the unusual wartime conditions, in Detroit, which was practically 100 per cent on wartime production, those plants which had carefully developed labor policies, and which had centralized their employment functions, had turnovers ranging from one-tenth to one-half of plants which were devoting but little attention to personnel or employment work.³

Centralization of employment work for the production forces can be justified on the following grounds: although the foreman may have much knowledge of the detailed requirements of jobs, his experience and the time that he is able to devote is not usually such as to make him expert in the selection of workers; the foremen cannot be expected to develop outside contacts as sources of labor in a way that a centralized department can; individual foremen are not in a position to perceive the needs of the plant as a whole, and thus the centralized department is more likely to achieve that uniformity in selection which makes for a generally high character of personnel and *esprit de corps*, to place an applicant in the department for which he is best suited, better to arrange in merited cases for a transfer of jobs, and better to prevent undesirable former employees from being rehired. If centralization of employment of the production forces be once achieved, it is likely that the same policy will be shortly extended to all other departments of the business.

It is not unnatural that foremen, old in industry, should resent with much force the withdrawal from them of the right and prestige of hiring. Many such foremen feel that unless the worker receives his job from them, they will have little control over him. Such views should be given due attention in the development of the employment department. They

³ See Monthly Labor Review, January, 1919, pp. 11-19.

constitute very excellent reasons why, except under unusual conditions, foremen should be given the right to reject applicants tentatively approved by the employment department.

Qualifications of employment department personnel. To insure the high standards of operation which are usually expected from the creation of the employment department, the employment manager must be a man of broad vision and winning personality. He must be able to win the confidence, sympathy, and appreciation not only of the employees, but of heads of departments. In order to build up this condition, the employment manager frequently is forced to keep his eye on long-run policies rather than on individual cases in which he may differ from the department head.

Under this policy, with the development of a well-run employment office, the cases in which selections made by the employment department will be rejected in the operating department will be very rare indeed. There is usually no necessity of sending more than one candidate to the department head, because, after a period of time, the employment manager soon learns the types of workers whom the department head simply does not like to have around. At times, after an employment department has become fully established and has gained the confidence of all departments, it is possible to place full responsibility for the selection of employees in its hands; but there should always be an interview between the applicant and the department head before final employment, so that the former may see what kind of a person he is going to work for and not meet his "boss" just as he is taking his coat off to get to work.

To make for soundness of selection, it is essential that the employment manager, or his assistant, whoever interviews applicants, shall have a first-hand knowledge of the requirements of jobs. Thus, an interviewer of applicants for workers in the shop should have shop experience. No matter how complete the employment department's record of jobs, there is no substitute for this. In addition to these qualifications, it is, of course, essential that the interviewer be specially qualified in power of analysis, in knowledge of human nature, and in constructive imagination.

In selecting employees, the employment department must fill requisitions which are submitted to it by the operating departments. These requisitions may be developed in conference at the time that some production or expansion program is decided upon, or may take the form of routine requisitions, which may be made out on specified forms, submitted by the departmental heads from time to time as necessity dictates. The cause of the vacancy should be indicated on the requisition. This will enable the employment department to have a written record from the productive departments of the way in which they are filling jobs. The

requisition should reach the employment department as far in advance of requirements as is practical.

Job specifications. The employment department is greatly assisted in its operations if it has developed a set of job specifications for all jobs for which it is called upon to supply workers. These specifications are of particular value in large organizations, where it is impractical for the employment manager or the interviewer to keep in mind the conditions of work of all jobs. In smaller organizations, it is possible that they will have a knowledge of the jobs which is more complete and accurate than anything which is likely to be developed on paper. Much information for job specifications can be secured from the methods department, or whoever has control of the taking of job studies. The employment manager should be entirely familiar with the job-study data which have been secured. In working up job specifications for his purposes, however, he frequently needs some information of another kind, and must also translate for his purposes much of the information on the job-study observation sheets. Job-specification data should not be too elaborate. There is likely to develop a tendency to detail a mass of information which it is impractical to utilize. Particularly when business conditions are good, it is impractical to try to fit workers too closely to the job at hand. There has been far too much talk during the past few years of square holes and round holes in the organization, which are to be filled with square pegs and round pegs by the employment department, these pegs to be in the form of new employees, and the holes in the form of job specifications.

We all know that even the most routine jobs, be they in the office, in the service department, or in the manufacturing end, are often transformed by the person who holds the job. Although this does not mean that every attempt should not be made by the employment department to find workers who approximate the ideal for a given task, it does mean that a new employee should be first of all an organization person, with some chance of fitting in with the group in the department in which he will work, and secondly, should have general qualifications fitting him to perform a type of task, rather than be theoretically a perfect specimen to fit the particular niche that is vacant. Business is dynamic, not static, and if the employee fits the particular niche too well, we are likely to find him fitting the original niche after it has changed shape entirely through the interplay of new forces or new ideas in the business.

Effective job specifications aid, not only in employee selection, but in his training and possible promotion. If they are intelligently utilized by the employment department they aid in preventing the overselling of the job to the prospective employee, with the resultant high leaving rate within a few weeks after employment. They should include a consideration of minimum qualifications of the employee, rather than maximum, a

full statement of the conditions under which the work is done, in order that the interviewer's memory may be refreshed when he is seeking a worker for a job, should indicate the pay, and the lines of promotion which seem to be open from the job. (See Fig. 102.)

Sources of supply. The development of sources of supply for workers and keeping in contact with these is one of the chief duties of the employment department. An available supply of workers when wanted is likely to be found most frequently by those organizations which have created for themselves the reputation of being good places in which to work. Establishing this reputation may be far beyond the powers of

1	2	3	4	5	6	7	8	9	10	
JOB NAME					THE AMERICAN PULLEY CO.					JOB SPECIFICATION
DEPARTMENT					1. GENERAL					SYMBOL
2. MINIMUM QUALIFICATIONS OF OPERATOR										
<input type="checkbox"/> MALE	<input type="checkbox"/> READ	SCHOOLING	<input type="checkbox"/> COMMON	NATIONALITY	FROM	<input type="checkbox"/> TALL				
<input type="checkbox"/> FEMALE	<input type="checkbox"/> WRITE	ENGLISH	<input type="checkbox"/> HIGH 1234	PREFERRED	AGE TO	<input type="checkbox"/> SHORT				
						<input type="checkbox"/> HEAVY				
						<input type="checkbox"/> MEDIUM				
TRADE EXPERIENCE NEEDED					PHYSICAL					
3. NATURE AND CONDITIONS OF WORK										
LOCATION	POSTURE	SPEED	ACCURACY	SIZE OF MATERIAL	AUTOMATICITY	HEALTH HAZARDS	DAINGEROUS FEATURES	ACCIDENT HAZARD		
MACHINES USED					PERSONAL TOOLS REQUIRED					
TOOLS USED					TIME REQUIRED TO LEARN OPERATION					
DEPARTMENT HEAD					EMP DEPARTMENT					
					DATE					

FIG. 102.—Front of Job Specification Card.

the employment department, involving, as it does, the whole personnel policy of the plant as well as its methods of operation, but it is of inestimable value in the development of a satisfactory, as well as a satisfied working force. The wage base can do more to provide or prevent applicants of the right character than most of the professional activities of the employment department. Plants in large cities have the problem of building up a good reputation in their particular portion of the community, inasmuch as it is found unsatisfactory to have large portions of the working force come from long distances. In no case is it usually possible to stop hiring persons who live at a distance from the plant, particularly when business is booming, but a good reputation within the nearby community will do much to add neighbors to the working force

and thus eliminate the lateness, absence, and high turnover which usually follow long rides to and from work. In small communities, where the prospective labor supply is limited, the possibility of securing the best available workers rests squarely on the general reputation that the plant builds up.

A large proportion of new workers must necessarily be selected from those who apply at the office, although this is generally the least satisfactory source of supply, particularly in good times. Applications by mail are frequently received, and they form a satisfactory source, particularly in the case of firms with good employment reputations, who are likely to attract workers already employed. Of course, follow-up interviews are necessary before selection, regardless of the amount of correspondence. Advertising for workers in newspapers merely increases the number of these two types of applicants. Workers already employed are likely to recommend names for consideration. Their recommendations may easily prove one of the best sources of supply, since they know the plant conditions and are not likely to recommend the names of others unless they feel that these will also be satisfied. However, there is a great difference between this and the selection of two workers, particularly girls, who apply together for the first time. It is likely in the latter case that if one of these workers becomes dissatisfied for any reason, the other will leave along with her.

Of the contacts which can be developed between the employment department and outside organizations, those with employment agencies need the most careful study. There are some employment agencies that go about their work in every bit as professional a manner as the best-conducted company employment department. Such agencies will recommend only persons who they feel confident will fill the opening. In every large community, however, there are many agencies which come just within the letter of the state law governing their operation, and which are not good contacts for the employment department.

An excellent source of contact, if any foreign labor is employed, is with the leaders of foreign elements within a community, either business men or clergymen. They are likely to know the reputation of workers within their group and will be glad to recommend the better ones as opportunity offers. Trade organizations are valuable aids, especially when there is some form of collective bargaining with labor in the plant. In some industries where collective bargaining has been established, particularly in the clothing industry, joint offices have been provided as an aid to the plant-employment managers. Schools, colleges, and specialty concerns who train workers in business practice, such as filing device distributors, all form valuable contacts. Frequently close relationships can be built up with technical high schools that will yield a very sat-

isfactory source of supply consisting of their graduates. Candidates for future executive positions are more and more found among graduates of colleges, and many such institutions have provided departments which aid the employment manager to get in touch with their students as well as with graduates who have been in the industrial world for some years. Each personnel department will ordinarily develop contacts which seem particularly desirable for their peculiar conditions, and upon the extent to which they have developed these will frequently depend the promptness with which they can fill requisitions made upon them.

Interviewing the applicant. It is in the interview with an applicant that the employment department has one of the best opportunities to justify its existence. It is not only in the selection of successful candidates that this is true, but in the method of selection, in the method of rejection, which should be such as not to create any ill-will toward the firm, and in drawing out of the candidate those points which are pertinent to a consideration of whether or not he is likely to be a permanent member of the working force. There can be no cut-and-dried method of interviewing. Each person must be treated in a different manner, and in a way which seems best to fit the case and best to draw him out. It is in drawing the applicant out that the success of the interviewer rests. Some of the most successful interviewers make it a practice to find out some interest of the applicant, and to speak of that for quite awhile until an atmosphere of confidence and ease has been established before the conversation is turned to openings or direct qualifications.

Application blanks have frequently been looked upon as the most important feature of the process of selection, and many of these have been designed from the standpoint of asking of the applicant every possible question that could be devised. This is wrong. Application blanks should be made as simple as possible, the questions asked should all have a bearing on the applicant's fitness for a particular job, or right to membership in the organization. Personal questions, which may aid the interviewer in determining the desirability of the applicant, should, however, be asked in the interview rather than on the blank. The tendency should be toward the procedure of the Curtis Publishing Company, where there is no "application blank," but in its stead is an "experience record." Furthermore, the application blank should be handed to the applicant in a way which will secure his co-operation in filling it out, rather than to have the effect of making him look at it as a piece of useless mechanism which must be filled in before the real business of the day can start. If the interviewer is really to learn pertinent facts about the applicant, the latter must be made to feel more or less at home. He is not likely to feel at ease in walking into a new plant, unless he be the undesirable type of applicant, namely the "floater." The application blank may readily be

used by the interviewer as a means of beginning the conversation with the applicant in the attempt to find out what kind of person he really is. This is one of its most valuable features, but the blank should not be looked upon as the basis of all hiring. It does form a valuable record of prospects in cases of applications of eligible workers for whom there are no immediate openings.

In all employment work, the major task of the management is to make the employee or prospective employee act in a wholly natural manner, and "open up" in conversation. Since this is true, it is desirable that all features of the employment office shall be constructed with this idea primarily in mind. It is therefore desirable that where the majority of persons being employed are women, the interviewer should be a woman, and where the majority of applicants are men, the interviewer should be a man, inasmuch as workers seem to express themselves more freely to members of their own sex. This holds true also for the higher positions in the personnel organization. Courtesy on the part of members of the employment staff is a fundamental necessity, if the plant is to be regarded in the community as a "good place to work." However, the attitude of the employment staff in this respect will nearly always reflect directly the basic policies of the company, without any conscious effort in that direction.

Employment tests. One of the mooted questions of personnel work is the matter of employment tests. Much has been written and many experiments have been made with these tests, both trade tests and mental tests, including general intelligence tests and rating scales. Their place in industry is still a matter of controversy, but it may definitely be said that they cannot be relied upon too extensively. Trade tests, which presume to test directly the abilities of the applicant for the job by having him do some work along the lines in which he is supposed to be skilled, unquestionably eliminate the "bluffer." But frequently it is necessary that a worker be given a chance to produce over a long period, because of the peculiar type of work or arrangement of machinery in the plant, or because of the scarcity of skilled workers at the time. If performance tests are set up there is a tendency to demand that the worker perform the operation in a particular manner, the methods rather than the results being what counts. Workers who would have difficulty in passing the ordinary trade test sometimes become among the most valuable in the plant under the guidance of a careful and painstaking foreman. Performance tests are valuable for simple types of work, such as typing.

Trade tests, which consists of showing the applicant a picture of a machine and then asking him a series of questions concerning it, or asking him for other similar trade information, are somewhat more valuable provided the test is used as a part of the general interview, and not given as

would be a Civil Service examination. Although the poorest worker may readily pass the best examination, in case his mind happens to run in such channels, nevertheless if properly devised such tests may gauge the actual ability of the applicant with considerable exactness. Oral tests which are included in the interview should be checked with workers' performance after being hired, in order to ascertain whether they actually are a guide to proficiency. If those who made the best records in the tests also make the best production records, the test may be presumed to be of value.

Mental tests, such as general intelligence tests, are of less proved value in the selection of workers. Many claims have been set forth for them, but they largely remain to be proved. Intelligence tests may give some idea of mental quickness or general knowledge, but they have not been developed to give a convincing test of fitness for specific jobs. Mental tests which are so designed as to check some particular ability may be regarded as somewhat more successful. Thus a test which will indicate quickness of perception may be utilized as a partial guide in hiring persons to do assembly work on small parts. Rating scales, which may be of some value in the promotion of executives, providing the rating be intelligently done, have but little or no place in the selection of applicants for any position. Their usefulness for promotion purposes has also been found to be questionable. All methods of character analysis by means of physiognomy have been proved useless, and most advocates of these methods found to be fakery in the highest degree. Any tests which are based on this idea are in reality only making the applicant for employment subject to the fundamental or acquired prejudices of the interviewer.

It is the task of the interviewer to sell the plant to the applicant, and to sell it to him fully, but it is likewise his task not to oversell either the plant or the job. The foundation of many other personnel activities is to be found in the impressions gained by the worker in his first few days in the plant. If the interviewer is successful in his relations with the workers whom he is interviewing, he can develop an attitude toward the plant which will go far to make the worker feel at home during the first trying days. No matter how badly a worker is needed, it is distinctly bad policy to oversell the job. This may be done by exaggerating its good points, or by consciously or unconsciously not mentioning all its bad points. The bad points will be discovered quickly by the worker. If he be not prepared for them, there is the likelihood that they will appear even worse to him than they actually are.

Physical examinations. In plants having physical examinations of applicants, with a doctor always in attendance, this examination may readily be given before introducing the worker to the foreman. In plants where the doctor only pays periodic visits, the examination may come after the worker has been provisionally at work for a day or two. This

mainly depends on the purpose of the examination. It is largely used to-day, not as a means of complete rejection, except in cases of communicable diseases, but as an aid to intelligent placement and follow-up. Unless there are physical examinations, it is very likely that workers will be assigned to jobs which are beyond their strength, or to which they are peculiarly unadapted from the physical standpoint, when they might as well have been assigned to jobs which they could satisfactorily perform. Many workers and some workers' organizations have objected to physical examinations because they have felt them to be predicated on the idea of rejecting the employee if he was not 100 per cent physically perfect. Of course, there is usually no such idea, but nevertheless there is a certain fundamental reaction which springs up in large numbers of men against taking a physical examination before they are given a job. This is a fact which must be recognized and guarded against.

The Curtis Publishing Company has recognized this and has seemingly found the solution. Instead of applicants for employment being told that they must pass a physical examination before being sent to the job, they are told that it is desired that they should meet the plant doctor. He is there for the purpose of aiding them in case they shall become ill, and therefore they should meet him and know who he is. No prospective employee can object to this sort of an introduction. In fact, he is usually glad to meet the doctor. He and the doctor begin to talk about commonplace matters, the last job the man had, etc., until the doctor can easily swing the conversation into a discussion of his health. Then it is discovered that the man is subject to frequent headaches. The doctor suggests that it may be due to defective eyesight, or other similar cause, and asks the man, for instance, if he has ever had his eyes examined. This leads in turn to an examination, and the doctor is enabled to secure as much of a physical examination as he deems necessary without the worker objecting. In fact, there is developed a bond of friendship between the doctor and the worker which causes the latter to be very ready to come for medical advice in the future.

Introducing the worker to the job. The function of employment does not end with acceptance of the worker by the employment department, and with his acceptance of the job. One of the best ways of having a new worker become dissatisfied with plant conditions is to have him misunderstand them. If the new worker is started to work without any adequate explanation of the aims and policies of the concern, and if his job is detailed and repetitive, day in and day out, is it surprising that he cannot readily be gotten to listen to tales of the "real aims of the plant"? It is desirable that he be given a bird's-eye view of the plant, its history, policies and aims, and be shown his connection with all of this. One of the commonest ways of attempting this is through a booklet which

is handed to the employee at the time he begins work, and which may have any title except "Regulations." Some concerns place the name of the employee on the cover of the book. As previously stated, a personal introduction of the worker to the man under whom he is going to work is a necessity. Either the foreman or the employment-department representative should be careful to introduce the new employee to those around him, and to show him the facilities for his personal comfort, such as locker and wash rooms, as well as those phases of plant routine which intimately concern him, such as entrances, clocks, methods of securing pay, and various service features. The R. K. Le Blond Company, of Cincinnati, has its director of employees' service send a letter to each new employee during the first week of his employment, inviting him to a dinner at noon in the plant restaurant the following week, at which time a special table is reserved and he not only has an opportunity to meet his fellow-workers, but all important safety, employment, and recreational features of the plant are described.

Not only should the worker be properly introduced to his job, but he should be carefully followed up, especially during the period immediately after he is employed. That is the period of most difficult adjustment, and the time during which the heaviest turnover figures are run up. In some plants, representatives of the employment department, sometimes even the interviewers themselves, go to the various departments and talk with those who have been recently hired, in an attempt, not only to secure the reactions of the worker to his job, but to check up on the judgment of the employment department, so that transfers may be made if necessary and advisable, at the time they will do the most real good.

Transfers and promotions. Inasmuch as the employment department is charged with providing a satisfactory working personnel for the organization, it follows that control of transfers from department to department or of promotions must rest largely with it. The matter of transfers is often a ticklish problem, particularly if the reason for transfer is the fact that the employee did not get along with the head of his department. The latter may readily rise to a point of personal privilege and demand that the worker not only leave his department, but the organization as a whole. This will frequently be difficult to deny and almost as frequently unwise to deny. But there are times, even in disciplinary cases, where it is desirable to transfer workers from one department to another. If the general impression is created that workers are in the employ of the concern at large rather than in any particular department, this practice is made easier. It may, however, easily be run into the ground, and cannot be carried on at the expense of discipline. Most transfers will be caused by errors in placement, rather than personal difficulties within the department.

A promotion system, which frequently involves transfers, is a most valuable adjunct to any personnel policy, where it can be worked out. Lines of promotion should be clearly defined wherever possible, and every effort made to create real lines of promotion. Frequently simple promotion schemes are effective, such as transferring a worker from dirty or greasy work to clean work, or from a night shift to a day shift. One of the reasons why a well-developed system of promotions and transfers is necessary, is that if some such scheme is not worked out, there will be small chance of preventing the department head from keeping his best workers in the jobs that they hold. He is principally out for results at lowest cost. That is why he is there. But he may seek immediate low cost rather than ultimate low cost. If morale is important to ultimate low cost, as it unquestionably is, promotions are necessary, for there is nothing that builds up morale as does a real promotion plan. This does not mean that personnel should never be brought in from the outside for executive or subexecutive positions. On the contrary, if an organization fills all executive vacancies from the ranks, it will lack the drive that comes from new ideas, and any promotion policy must be tempered with this knowledge. It is often possible to develop a promotion policy which will work well theoretically, but not practically, because the head of the department from whom it is desired to transfer an individual, knowing that person's worth, which, after all is the reason for making the transfer, will say, in effect if not exactly, "If this worker is worth that much to X, he must be worth it to me." But this idea carries with it the idea of increase of salary on the particular job. A job at higher salary in another department might be open, whereas an increase of salary on the particular job that the individual had been on might throw the salary out of line with that paid for other similar work. Any discussion of a promotion policy must ultimately come back to the point that wage schedules must be right. Otherwise there will be so many inequalities that transfers and promotions will be difficult to make.

A promotion scheme, including a lines-of-promotion chart, cannot always be drawn out and posted, particularly in small organizations. Nevertheless, the employment department always can be working toward such a scheme; and in large organizations, where there are the most blind-alley jobs, the development of the idea is easiest. The aim is to insure that the worker has the maximum of responsibility and earnings possible, and the firm has the benefit of the greatest ability. In working out such a program, quantity and quality of work, length of service, attendance record, number of dependents, age, and physical and mental fitness must all be taken into account. Where it is impossible to work out lines of promotion from job to job, it is usually possible to work out a scheme of wage

increases with length of service, which, while not providing the same spur for all workers as changes in position, readily serves for some.

Discharge, quits, layoffs, records. Policies differ concerning the extent of control of the employment department over discharge of employees. In most plants which have developed employment departments, the employee must at least pass out of the plant through the employment office, in order that a record may be obtained of the reason for the severing of the connection. Some plants allow the department head only the power of discharge from his department. However, if the matter has gone so far that an executive of the organization has actually discharged a worker, it is usually impractical to arrange either that he take the worker back, or that he submit to his transfer to another department. It is best to provide for a procedure whereby the department head comes to the employment office and talks the matter over before discharging the workman. If such a procedure be enforced, there is always a possibility that the department head may change his mind, or he may approve a worker's transfer to another portion of the organization, thereby saving the concern a portion of the investment in the individual, in cases where such action might be justified.

When the employee voluntarily quits, provision should be made that he be not allowed to draw his final pay until he has checked out through the employment office. This will enable an effort to be made to retain him, in case this should be desired, and at any rate an attempt may be made to secure information concerning his reasons for leaving. Such information is of more value than the mere preparation of statistics. It enables the employment department and, through it, the general management, to understand the features of the plant itself and the industry in general which must be remedied if the costs of labor turnover are to be reduced.

Many times men are laid off from the working-force of a department, because of a reduction of work there, who can readily be used in other departments of the concern. In such cases, an orderly procedure, rather than a mere dismissal of the employee, will frequently result in the retention of many employees who can be used in other positions.

A statistical analysis of the number of workers employed in each department, the number hired over a period, and the number of exits, carefully classified, is a measuring stick of the effectiveness of the labor policy of a plant, and of the effectiveness of operation of the employment department. The number of exits should be carefully subdivided as to voluntary withdrawals, those laid off, and those discharged. It is in the subdivisions of these main causes of exits that the most valuable data will be secured for the development of the personnel policy. Whether the

voluntary withdrawal is because of dislike for the work, "better job," which frequently should be interpreted higher pay, conditions at home, or other reasons should be fully investigated before the employee is allowed to leave. At times the real reason cannot be ascertained; but at other times, if as much care is given to the interview when quitting as is given to the interview at selection, some real information will be secured for policy-determination. The first cause given by the worker cannot always be accepted as the real one. In addition to a compilation of causes of turnover, the employment department can prepare other interesting and valuable bits of statistical compilation, such as an analysis of the working force according to earnings, according to length of service, or nationality. These analyses can also be combined with turnover statistics by departments as an aid in policy formulation and better selection.

CHAPTER XXXI

SERVICE WORK

NEXT to "efficiency man," the most unpopular phrase in the industrial vocabulary is "welfare work." The idea that this constituted doing something for the working man which would better his "condition," coupled with the plant-advertising features which frequently were part and parcel of it, has eliminated welfare work from successful industrial management. In its place has been substituted "service work." Not that there is anything in a name, but there is much in the different attitudes which these two phrases express. Service work includes all those activities which are not directly concerned with production, but which make the plant personnel a healthier, sounder-thinking, more forward-looking group. To avoid the pitfalls which caused the idea of welfare work to fall into disrepute, the plant must studiously avoid any semblance of the attitude of saying, "See what we are doing for you." The only excuse for a management including service work as a portion of their program is that it will make the employees a group of citizens who will be better able to carry on the productive processes, or that it constitutes a development which has been approved by the express will of the employees.

Careful analysis of the motives of the plant management in engaging in service work will enable it better to understand whether some particular feature is or is not a desirable adjunct to work already carried on. Thus the fundamental concept should be carefully analyzed by the personnel department and the plant management as a whole, to see whether the work is carried on wholly because it pays, since it acts as an incentive to the working force, or partially on humanitarian grounds. On this analysis will depend partially, but not entirely, the method of organization of the work, that is, whether it shall be carried on by some branch of the personnel organization, perhaps called the service department, or whether it shall be organized as an employees' activity, possibly supervised by the management. Wherever service work can be organized on the latter basis, greater results will ordinarily follow from an equal amount of effort. However, some company contact with the situation is necessary not only to give advice, where needed, but also to prevent the activities from degenerating into the football of opposite political camps within the employee group.

Locker rooms and rest rooms. There are certain features, generally classified under service work, the desirability of which cannot be questioned, either from the standpoint of the employer or of the employee. They are in reality a portion of any sound policy of operation and are placed under the personnel division merely for convenience of administration. Such activities are the operation of adequate locker rooms and wash rooms. Locker rooms should provide individual lockers and wash rooms should be constantly supervised and kept clean. Rest rooms for



Courtesy S. B. & B. W. Fleisher Co.

FIG. 103.—Women's Rest Room, S. B. & B. W. Fleisher Co., Philadelphia, Pa.

women (Fig. 103) come under this heading, and are uniformly desirable, if not maintained on too elaborate a scale. The objection is sometimes heard that they have a tendency to keep women workers away from their job unnecessarily. In large plants rest rooms must be supervised; but this would be true, no matter how meager the wash-room facilities, even though they came in only under the letter of the state law. The fact that rest rooms can be utilized only for a short period of the day, during the noon hour, is no argument against their establishment. They are provided to be used when needed, and as a means of relaxation during the period. Simple furnishings, and perhaps a phonograph, bring only a small drain

on the resources of the company, which is paid back amply by the added production of the woman worker who has felt the need of using the rest room for a few minutes before the afternoon working period or perhaps during the working hours. The demonstrated fact that workers seldom use these rooms after working hours, which has discouraged some plant managers, has no significance. They have ordinarily been established as an aid to the day's routine, not as club rooms.

Health service by the medical department. The functions of the plant doctor have come to include more than a physical examination of applicants. Many organizations in which there are no physical examinations for employment have a plant doctor, either on a full-time or part-time basis. The proportion of time that he is at the plant usually depends somewhat on its size. He maintains a dispensary with a nurse in attendance, not only for accident, but for health (Fig. 104). If the plant be fairly large and the doctor be on a part-time basis, the dispensary is usually in charge of the nurse, who, when occasion demands, will also go out to the homes of workers who are ill and who desire her aid. This home visiting may take the form of a systematic follow-up of all workers who do not report for duty on a given day. When thus organized, it has the added purpose of decreasing absenteeism. Such home visiting must be carefully handled if the attitude of paternalism is to be avoided.

The greatest function of the medical department, if organized to give health service, is to keep the worker well and on the job. If the confidence of the workers can be secured so that they will report to the dispensary when they first feel ill, it will usually eliminate a large share of absenteeism, and may possibly check the spread of an epidemic within the plant.

The physician should make definite arrangements for the care of all health complaints, the disposition of chronic diseases, and the special investigation of occupational diseases. Health instruction of employees means personal talks intended to clear away ignorance and to prevent exploitation. The physician likewise should guard the company against exploitation in the matter of health appliances and fads, advanced by commercial interests. Communicable diseases demand practically daily watchfulness, with foremen instructed to be observant. Likewise, health officials must be quickly informed of epidemic or multiple illness of all types. Trivial illnesses, first-aid, dental prophylaxis, ocular attention of prophylactic and emergency nature, as well as the usual provisions for surgical treatment of minor injuries, should obtain. Except in isolated communities, as a rule, major surgery and sickness should go to outside hospitals or elsewhere. Finally, compensation approvals must pass under the physician's scrutiny.

Industrial physicians should be allowed to lay stress on health com-

plaints made by workers and not wait for sickness disability. Surgery, in the face of disability statistics, certainly requires much less stress than ordinary sickness. Real occupational diseases constitute a very small part of the sickness disability which occurs among workers. It has been found that sickness causes twenty times as many cases of absenteeism as accidents and is responsible for seven times as much loss of time from work. True, the greater portion of sickness disability among workers is extra-industrial in nature and is equally prevalent among adults of like ages and sexes in the community, perhaps more so; but a considerable part can be greatly influenced by industrial environment and methods of personnel supervision and, as such, is capable of considerable reduction in the matter of days of absence from work.¹

If a medical department to give health service be installed, it is best that it be under the control of a highly competent physician, even though he give only part of his time to the work. A medical department can do much to reduce compensation claims and loss of production time, but only if it is skillfully directed. Industrial physicians and nurses must understand the human side of their daily contacts. They must at least be given a cheerful place in which to work, and one that is central enough to make it convenient to all the workers. It has been found impractical for most plants employing less than 500 workers to employ a physician on full time. Plants employing from 500 to 2000 workers may or may not employ a full-time physician, while plants with over 2000 workers almost uniformly do. These facts, together with the cost of medical department operation, have been worked out in a very complete study by the National Industrial Conference Board.² This study indicates that the annual cost per worker of well-organized medical departments will range about a \$1.50 average, the cost for the smaller plants being higher, or in the neighborhood of \$6. These figures cannot be viewed properly without considering the reduction in compensation claims and lost time and the increase in general contentment, due to the good health that such departments bring. But aside from the monetary aspects, the general betterment of the health of the community which is likely to result from providing facilities for workers to consult competent physicians should weigh heavily in favor of the introduction of plant health work.

The well-organized medical department will be able to collect a mass of highly useful data for the personnel and production executives concerning unhealthful conditions and unsafe operations within the factory. The checking of causes of absence can be done only by a factory nurse.

¹ Adapted from address by Emery R. Hayhurst, M.D., Ohio State University and State Department of Health, Columbus, before Conference on Women in Industry, Special Bulletin No. 10, Pennsylvania Department of Labor and Industry.

² Research Report No. 37, National Industrial Conference Board, pp. 10-11.

The only possible excuse for entering a workman's home when he does not report for work is on the basis of being helpful if he is sick. If it be found upon calling that the worker's absence is due to any other cause there is but one procedure, namely, to withdraw promptly. Any other action is paternalistic to an impossible degree. Nevertheless, a clever factory nurse can secure much useful information in making her rounds, and her value in reducing absences is not confined to aiding ill workers to return to work more promptly. Her visits have a strong moral value, too, inas-



Courtesy S. B. & B. W. Fleisher Co.

FIG. 104.—Dispensary, S. B. & B. W. Fleisher Co.

much as they indicate more strongly than any amount of regulations by the management, the importance of being on the job. No plant can long afford to carry workers who are consistently absent without cause, and the factory nurse is the proper person to find out the cause. The visiting nurse will serve as the basis for administration of sick funds maintained by any mutual benefit association in the plant. She should also be closely in touch with any charitable organizations in the community which might be interested in aiding workers whose illness has left them temporarily in bad financial situations. Some companies feel strongly that it is very

desirable that the handling of such cases be called to the attention of such duly organized agencies, and left with them.

Dental work has been added to the field of operations of some medical departments. Employees are usually charged for this service, though the prices are ordinarily based on cost of materials, with possibly some addition which partially pays the dentist's time. The large number of cases of ill health which are traceable to the teeth are usually felt to be the justification of such work, if it exists. In some cases, while the work is done on company time, the actual cost of the work to the company is charged to the employee.

Health service can be made very profitable to both the employee and the plant, but every effort should be made to secure the good-will of the employees toward the idea, in order that they may not hesitate to visit the dispensary. Much can be done toward the creation of the desire to visit the dispensary in the first contact which the physician makes at the time of physical examination. Care must be exercised in the operation of a factory health service that it does not unjustifiably infringe on the province of the local medical community, and particularly on the precincts of the family doctor of the employee.

Educational work. In turning from medical work to educational work a field of service work is entered which can be very readily overdone. This type of educational work does not deal with the training of the worker for his job or for direct advancement, but with general education along varied lines, such as Americanization and thrift. Such work can frequently best be carried out by the formation of clubs among the employees, which will be able to carry on the educational work with but little guidance from the service department. If a plant library is to be established, which is sometimes particularly desirable in small towns, it can best be put under the supervision of some employees' club or association, although it should not be necessary that any employee be a member of that organization in order to secure the benefits of the library. Americanization work can readily be carried on by interesting some employees in it, and allowing them to act as instructors for the group. Educational work along the lines of thrift and sound financial advice is frequently possible, but can probably best be carried on through the plant paper. "Before you invest—investigate" is a slogan which has proved helpful in the development of a sound investment campaign. In case there are savings funds or other similar plant organizations, thrift education can best be handled by these.

Restaurants and cafeterias. The maintenance of plant restaurants and cafeterias has become almost universal. Even when the neighborhood is blessed with fair places to eat, it has come to be regarded as desirable to institute a plant cafeteria. This makes possible not only the development

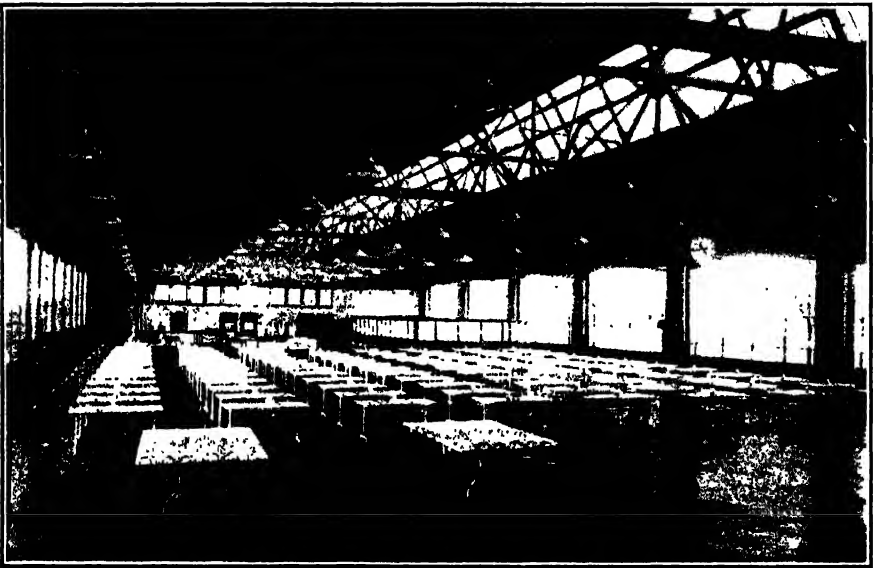
of *esprit de corps* through the meeting of fellow-workers, but insures that workers will toil through the afternoon hours properly nourished. It is these features that make the restaurant a dividend-paying investment. Since profit is forgotten, costs in factory restaurants are usually a fraction of costs in ordinary restaurants. This is particularly true because costs are usually based on cost of food and service, overhead being eliminated. With the poorer portions of the working force, and with women workers who are also housewives, the factory restaurant makes for an opportunity to get at least one good meal a day. Women who would not take the trouble to cook themselves a real meal at home, even if they had the funds to provide it, will frequently make the noon meal at the factory their main meal of the day. Thus the factory restaurant, like the medical service, tends to promote the health of the worker.

Where it seems desirable, the restaurant may be given to a restaurant company or an individual on contract, provided careful supervision is maintained over its operation. Wherever possible, it is desirable that it be operated by the plant itself. The establishment of a plant restaurant makes possible the enforcement of regulations against eating in the work-rooms, and it is most desirable that these be enforced. Practically every company maintaining plant restaurants allows the workers to bring a portion of their meal from home if they so desire. The cafeteria style of restaurants finds most favor because of the lower cost and the speed of its operation. (See Fig. 105.)

The restaurant may readily be made the center of the service activities of the firm. If entertainment features are desired, these can be provided in the restaurant, either during the noon hour or at other times. It can be made the center of employees' or departmental functions, and gives an assembly room upon which there is little desire or likelihood of encroaching.

Recreational and athletic activities. In the attention paid to recreational and athletic activities lie some of the dangerous spots of service work. Recreational features may take the form of dancing, music, or speeches during the noon hour, plays, band concerts, or dances given by workers at intervals throughout the year, or the development of clubs and club-houses. These features, particularly the latter, are bound to fail unless the basic wage of the plant is right. The workers will quickly see that they are costing the firm an outlay of considerable money and will be likely to demand that it be put into their pay envelopes, unless they are already fairly well satisfied with the contents of these. If professional talent be available, it may be called upon infrequently for short concerts during the noon hour with satisfactory results. However, speeches are not usually received with pleasure, and many workers show a disposition to want to spend the noon hour as may strike their fancy. Plays and dances are valuable if they are fostered by the employees,

through organizations of their own, which only call upon the service department for guidance. They are particularly workable in small towns. The plant band in the small-town organization likewise becomes a unifying influence for good, whereas in the big-town organization it is likely to fail, except in large plants, where it is usually regarded as would be a professional organization. Clubs, particularly country clubs, laid out on a large scale, cannot possibly be successful unless the management has the complete good-will of its employees. There is too much opportunity for the criticism of large expenditures. If the *esprit de corps* has not been worked up to a high pitch before the opening of the club, it will

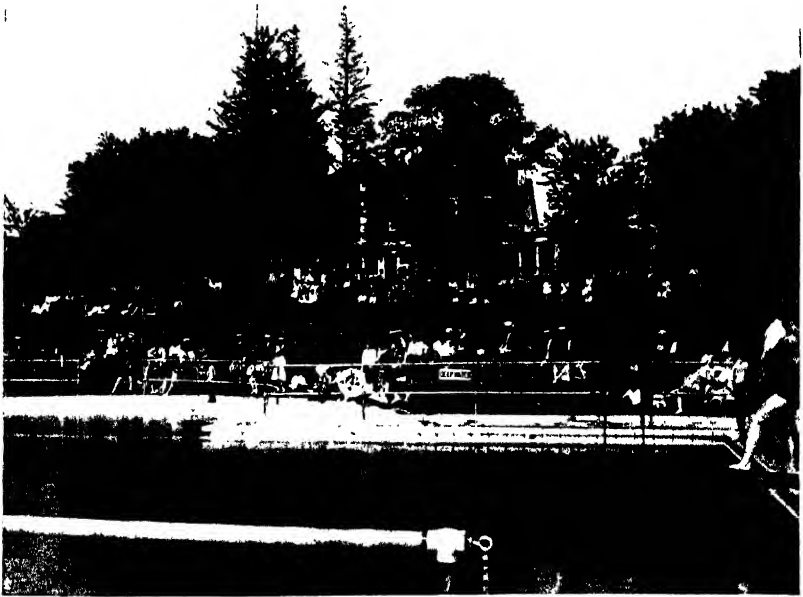


Courtesy General Electric Company.

FIG. 105.—Cafeteria, Philadelphia Works, General Electric Company.

be difficult to get whole-hearted co-operation of all elements within the working force for its support. Clubs, after formation, cannot be operated except as employees' organizations, and since they involve large investments on the part of the company, it is necessary that steps be taken when they are organized to prevent internal politics in these organizations from wrecking the project. If a plant be properly situated, and if all fundamental conditions be right, there is no feature of service work which will do more to cement the mutual understanding of all elements within the plant than will a club. However, it is essential that all employees, whatever their plant status, be given an equal status within the walls of the club, if this is to be true.

At the country club of the Aberfoyle Manufacturing Company (Fig. 106) located just outside of Chester, Pa., there are tennis courts, swimming pool, baseball field, traps for shooting, locker and shower facilities, open-air pavilion for dancing, and a large and attractive club-house. The membership fee is 50 cents per month, deducted from the pay envelope monthly, or \$5.00 per year in advance. The privileges of the club are restricted to members, their families, and guests of members. A total attendance of over 40,000, during the summer season alone, indicates the popularity and benefits of the club. Membership is optional.

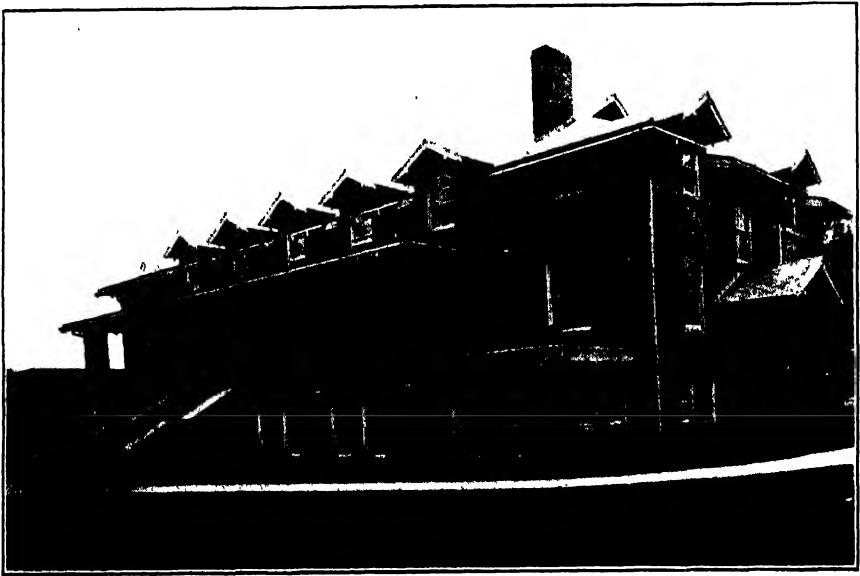


Courtesy Aberfoyle Manufacturing Co.

FIG. 106.—Country Club of Aberfoyle Manufacturing Co., Chester, Pa.

Athletics, while valuable, have been carried to an extreme in many organizations. Inter-departmental competitions tend to raise the spirit of the departments, and girls' or men's basketball teams, and men's baseball teams are particularly successful. Athletics develop health and encourage that most valuable asset to any industrial concern, team-play. They develop plant consciousness and leaders. If plant teams are formed, the tendency toward professionalism and the hiring of workers merely for their athletic ability must be guarded against. Although for the moment a good team may seem to increase the interest of all the workers in the

team and hence in the plant, nevertheless, there will soon be murmuring about favoritism. Even teams which are composed of bona-fide employees tend to take the primary interest of the members during the playing season, and winning from other plants becomes so important that the routine work of the week is frequently relegated to the background. In small towns, where the company team is in reality the town team, these objections are frequently wholly outweighed by the good-will which the team will build up in the community. But too much time, too much attention, and too much money can readily be bestowed on athletic work which emphasizes competitive rather than health features.



Courtesy J. E. Strine Co., Greenville, S. C.

FIG. 107.—Many Southern plants have found it desirable to build Y. M. C. A. buildings such as that illustrated. This building, at the Champion Fiber Company, Canton, N. C., is exclusively for employees of this company, manufacturers of wood-pulp. In it are all recreational facilities ordinarily found in like buildings in medium-sized towns.

Employees' group funds. Particularly in large organizations, funds which are built up through associations of employees are valuable from the standpoint of the employee and the plant. Such funds are those of building and loan associations, benefit associations, and savings funds. Company group insurance plans and retirement plans are also very successful. The company cannot successfully operate savings funds itself, but it can urge the establishment of Christmas savings clubs, vacation funds, or building associations, and can lend the time and experience of one or more of its executives or lawyers to act as an advisor to such groups. The

boards of directors of such associations, to be successful, must be almost entirely composed of workers, with probably one representative of the management who will sit for the purposes named. Associations of employees formed for savings purposes of one kind and another form one of the most excellent foundations for the beginnings of co-operative management, such as will be later described. Savings funds usually work out best if they have some particular purpose in view, such as is found in Christmas savings clubs.

Group insurance. Group-insurance plans are utilized largely by companies as means of putting a premium on length of service. They are sometimes used together with increased wages for length of service, but frequently form the only length of service bonus. The provision for group insurance of this nature has increased greatly in recent years. Most of these plans are now contributory, that is, they provide for payments by employees into the insurance carrier, these payments being matched by the company. If the employee withdraws from the service of the company, he can maintain the insurance for himself, or can exchange it for its cash surrender value if he so desires. Some group policies have been written without any contribution from the company. In such cases, the company merely acts as the employees' agent in deducting premiums from the payroll and forwarding them to the insurance company. The advantages to the employees are lowest rates and no physical examination, because the policies are taken out on the group basis.

Retirement plans. Retirement plans are usually worked out on a scale which varies with length of service. The plan of the Colorado Fuel and Iron Company, which is typical of the best-developed retirement plans, provides for the retirement of all employees of sixty-five (women, fifty-five) after twenty years of service, or the retirement of employees of sixty (women, fifty) after thirty years of service, with certain special provisions for others. The retirement payments are 30 per cent of the average pay per month of service during the ten years next preceding retirement, with a minimum of \$20 per month. The plan is in charge of a Service Retirement Board consisting of five officials of the company, who have discretionary power to retire others than those affected by the major provisions, as for instance, employees who become physically incapacitated for service.

Because of several experiences, notably that of Morris and Company, it is best that company funds put into retirement or pension plans be placed in a special fund that can be used only for that purpose. Morris and Company, in selling their business, practically eliminated any chance for elderly employees who had been members of their pension fund for years to secure their expected pension. The company that bought the business did not carry on the pension scheme. Several other similar

instances have proved that it is best to set aside and earmark funds on an actuarial basis if a pension scheme is instituted.

Co-operative stores. Companies that manufacture articles of wearing apparel, or other articles which employees are interested in purchasing, usually maintain retail counters or stores at which employees may purchase the product at cost of manufacture. Other companies maintain retail stores for the purpose of selling groceries and other necessities. These are best operated on a co-operative basis, if criticism and ultimate failure is to be avoided. Frequently these stores will sell coal and other expensive necessities on the weekly basis. Articles are usually priced on a basis of cost plus handling charge, with inventories taken frequently and prices adjusted accordingly. Sometimes there will be an attempt to make a profit, with this profit turned over to the mutual benefit association of the plant. Some company stores remain open all day, as in the case of the Packard Motor Car Co. of Detroit, and the Multigraph Company of Cleveland, either workers or their families being permitted to make purchases. Other stores are open only just before and after working hours and at the noon period. The Hood Rubber Company, of Watertown, Massachusetts, utilizes a box into which orders can be dropped. These are gotten up during the day and are ready for the worker when he calls for them in the evening.

Social-betterment work. Social betterment work on the part of industrial plants is to be studiously avoided, unless municipal conditions, such as those discussed under "Industrial Housing" in Chapter IX, make such work an absolute necessity. Whenever it is deemed necessary, because of general living conditions in a community, for a plant to enter into this class of work, it should do so with a definite, developed program to withdraw as soon as possible.

CHAPTER XXXII

EMPLOYEE TRAINING METHODS

IN no other feature of industrial management is the size of the plant such an important consideration as in the organization and development of employee training. The size of the plant will often be the limiting factor which will determine whether this work should be undertaken, or, if undertaken, the scope which it may take. Training work, although usually valuable, is always expensive, and it will not prove profitable on a large scale in small organizations. By training work, reference is not made to the instruction of workers in methods of performing particular tasks, but rather training of a character which is general to the trade or job. In every organization, foremen, department heads, or specialists, such as time-study men, must instruct the workers in the performance of specific jobs. Such instruction merely warps the previous training and experience of the worker in a way which will enable him to perform his tasks more effectively. Such training is a portion of the supervisory process and must always be carried on.

Inexperienced workers are continually applying for employment in tasks which require experience. Frequently these may be eliminated by the employment department, but often they must be hired and tried because of the necessity for and scarcity of workers. And often workers, generally skilled in the trade, must be trained in the particular branch of the trade, if spoiled work, disabled machinery, or accidents are to be reduced to a minimum. Then there are great potential gains in training workers, already employed, for advancement, and in training foremen and departmental supervisors toward a better understanding of the company and their jobs. These are the phases of a general training program, and they must always be developed with the present and prospective size and general policies of the organization foremost in mind.

For industry as a whole, the days of apprenticeship seem to have definitely passed, and yet, with better production and management methods there has developed the necessity of having definitely competent workers on production jobs. Under modern industrial conditions, knowledge of materials, knowledge of machines, and knowledge of processes have become more important, as knowledge of the handling of tools has become less important.

Apprenticeship-training. Apprenticeship in its older forms has largely passed from industry. The increasing opportunity that lies before a young man to gain a relatively large wage in a short period by learning to operate semi-automatic machinery has been the cause. He will no longer consider binding himself out for a period of years at nominal wages in order to learn a trade. The growth of educational opportunities has partially absorbed that proportion of the younger generation which might otherwise be sufficiently forward-looking to take up apprenticeship-training. Such training is found to-day only in the larger plants, which, because of the large number of all-round workers that they need, can afford to introduce training courses and stand the expense of training workers who may not remain with them. Thus, such companies as the Westinghouse Electric and Manufacturing Company, the Goodyear Tire and Rubber Company, the General Electric Company, and the Ford Motor Company have found it profitable to develop apprentice courses. In these are enrolled young men and boys fourteen to eighteen years old, or more, who are trained for three or four years, paid wages for hours of instruction, as well as hours of production, and then at the end of that time are graduated as qualified journeymen and given \$100 or \$150 and their kit of tools. Companies in other industries have given freely to trade schools, which give the equivalent of an apprenticeship-training, as in the case of the textile industries of New England and the textile schools there.

Vestibule schools. Most plants have not been able to afford to introduce apprentice-training on a large scale, although some have been able to train a few apprentices from time to time, particularly if their work be unusually skilled. Most industrial training has recently taken the form of training for the task rather than for the trade. One of the more recently developed forms of such training is the "vestibule school," which teaches operations rather than principles. This is a preliminary training shop specially designed for instruction, through which new employees are taken before being allowed on the production floors. It came into particular favor during the War period of 1917-20, because of the large number of workers who were engaged in occupations with which they had been previously totally unfamiliar. Sometimes this training takes place in a separate room and sometimes in the corner of the actual production floor, which is somewhat better where feasible, since it makes possible the immediate acclimatization of the new employee to the shop atmosphere of production. This same consideration makes advisable that whatever work shall be carried on in the vestibule school shall be a part of the regular production, turned out on regular machines. It must, of course, be a kind that is suited to beginners, but the regular standards of quality should be adhered to.

The Norton Company, of Worcester, Mass., manufacturers of abrasives and grinders, have developed a satisfactory training system of this nature which provides a six-week course for machine workers under the direction of a special director of training. They feel this has made for better workmen at less cost of accident, production, and turnover than would be secured by other methods. The cost per man, over and above production, of such training, is around \$70 for them, an amount which they consider to be far less than if the man were allowed to go directly into the shop. In addition, they utilize this school for training workers who wish to learn the operation of machines other than the ones they have been working on.

The vestibule school has fallen into great disfavor since the War period. There are times when it seems to be the best type of training, as when the job is unusually hard to learn, as contrasted with similar jobs within the industry, or when instruction seems to be impossible in the shop because of unusual conditions of production. However, it has many disadvantages. No matter how great the attempt, it is difficult to reproduce actual working conditions. It is difficult and expensive to have sufficient machinery of each type in the plant set up in the school for instruction purposes. Because of the uneven demand for new workers, either part of the vestibule school is usually idle or workers are rushed through it without the desired training.

Training the worker in the shop. Most forms of employee-training involve the instruction of the worker on the production floors while engaged in the regular processes of production. In training in this manner, no additional equipment is necessary, but it is essential that the work be constantly checked up to insure that training is actually carried on. Such training is either by or under the immediate supervision of the foremen. This is an ideal method of training under modern industrial methods, because the foreman, having been relieved of many of his previous duties, is left free for supervision and training work, his logical field. All foremen are not inherently successful teachers, but if they have as complete a knowledge of their work as may be expected of them, they may themselves readily be trained to impart their knowledge to others. This may be done by whoever has general charge of training within the organization. Foremen are often aided in instruction of beginners by an assistant particularly designated for that work, in case of large departments, or by designated workmen in smaller departments. Under the latter method it is necessary to reward the worker for giving the instruction. Success will usually follow training under the foreman, if it be made clear that this is one of his chief duties, and if means are provided of following up workers to see that they are, in fact, receiving training and are not being let to drift.

Training for promotion. Any promotion program which may be

adopted by a concern cannot be allowed to rest with the development of lines-of-promotion charts. This is particularly true of promotion from one shop job to another. Means must be provided to allow for the training of deserving employees in tasks that are higher on the promotion scale. With the vestibule school this may be accomplished readily, and such a program allows for the utilization of this school during times that it might otherwise not be busy. Without the vestibule school there is necessary a thorough education of the various foremen in the desirability of the program, and a continuous follow-up, by means of accurate records, to see that employees who are in fact successful are being prepared for advancement by their supervisors along the lines which have been laid down by the promotion program.

Training subexecutives, foremen, and supervisors. Subexecutives hold a new and very important place in industry to-day. Upon them devolves the task of directing wisely the huge mass of industrial workers. To them these workers look for guidance and for an interpretation of the policy of the company. To the employee the foreman stands for the management of the plant. The development of modern industry from a stage of craftsmanship and small shops to one of machine production carried on in vast buildings—often only one group of a chain of enterprises under the same management—has automatically made the foreman the interpreter of the management to the men as well as the director of production itself. In this dual capacity the foreman stands between management on the one hand and the rank and file of workers on the other—a peculiarly difficult and at the same time a powerful position. Among his responsibilities are the standard of production, the quality and quantity of work; indeed, upon his shoulders rest not only the stability and effectiveness of the industrial fabric, but the fulfillment of the aspirations of thousands.

Much can be done to train these men for their tasks merely through the method of organizing the enterprise, as was explained in considering the committee idea in organization.¹ Much more can be done through intelligently handled plans of foreman and subexecutive training. Such training must primarily aim to develop the qualities of leadership of the foreman or subexecutive. It must broaden him, and at the same time must develop such qualities of analysis within him that he may be able to visualize his job as he was unable to do previously, and as no training course can enable him to do. One of the most important aims of such training must be so to develop the foreman that he will be able to find ways and means of winning the confidence of those under him to an extent far beyond his previous ability. Regardless of the formation and operation of a personnel department, which will endeavor to win the complete

¹ See Chapter VI.

confidence of the working force, it is but natural that a large proportion of it will continue to look to the foreman as the means of contact with the firm. Thus, the foreman will be likely to occupy a natural place in the esteem and confidence of the workers which cannot be duplicated by any artificial relationship which it may be attempted to establish. Workers, particularly men, will confide to a foreman matters concerning their home affairs that will enable him better to exercise his supervisory authority and to dispense supervisory justice, provided he has won their esteem. But properly to evaluate this information and to consider it along with the requirements of the company necessitates both the power to analyze and actual knowledge of broad company policy.

Foreman and subexecutive training should result in furthering the ability of these members of the organization to analyze themselves and to see better wherein they are living up to the important trust which has been placed in them. It should result in encouraging the subexecutive to see the plant as a whole and to see his relation to it. Furthermore, it should so develop these members of the organization as to qualify for them advancement to positions of greater authority, as these become available.

Caution must be exercised in the methods of training which are used. Subexecutive training is another one of those management ideas which has been both grossly over-used and grossly misused. The training must be carefully developed, lest it result in the swelling rather than the growing of those who are being trained. This is likely to result from too much unstinted reiteration of the great importance of the subexecutive to the business. Some types of men can listen to discourses of this kind for a long while and still see relationships. Others will merely go back to the shops more fully convinced than ever of their own importance. Furthermore, if the inducement of advancement is held out by the firm as the bait to attract the subexecutive to the training, there is likely to be much disappointment when it is realized that for every possible promotion that may exist, there are now a number of trained candidates. Last but not least, managements must be careful that they do not encourage the enrollment of their subexecutives in training courses which advocate policies which the management is not ready and willing to see carried into effect. This is particularly true with that type of training involved in courses that bring together foremen and department heads from a number of plants and which take up the more advanced phases of management technique. Foremen, particularly, who receive this training and who find themselves both unable to advance to higher position and unable to put into effect the methods which they have learned, are likely to develop a very bitter attitude toward those higher up in the management. They are soon likely to feel that it is the management, not they, that needs the training.

There have been two general types of subexecutive training developed, that which provides for discussions of methods, policies, and trends by the supervisory force of one plant at meetings held at the plant, and that which provides for enrollment in general groups of supervisors from a number of organizations. The first plan is by far the more desirable, where it can be adopted, but small concerns, located in large industrial communities, will find much to attract them in the latter method. In the one-plant groups there is an opportunity provided to relate all discussions to the problems of the plant and the individuals who compose the group. Where such groups do not provide the training which it is desired that any particular supervisor have, such a person may be individually advised to join some general group, or some particular home-reading course, trade school, or evening course. However, to secure the benefits of real training, it is essential that any groups organized within the plant be very homogeneous, in order that topics which are of direct interest to all may be discussed. Several training groups may well be organized. If large groups, composed of all executives, are to be formed, it is necessary that the material discussed be confined to general matter, or matter that involves the co-ordination of activities of nearly all those present. Such plant groups can often be handled to best advantage as a part of a foreman's club, or some such activity. However organized, it is essential that attendance shall in fact, as well as in theory, be optional, although, once the group is organized, it will be necessary for the leaders to take every possible step to insure good attendance. This can best be done by making all meetings snappy and full of interest, but it also can be aided by the development of incentives of some nature. These need not necessarily be cash bonuses, but may be return of a payment for the instruction if a certain percentage of attendance be reached, or may involve extending certain privileges for further training.

Group training courses, which are open in varying amounts depending on the size of the town in which the plant is located, and which may be recommended by the management, include Y.M.C.A. courses, university evening and extension courses, and courses maintained by groups of plants acting jointly. Examples of the last class will be found in the very complete training programs for subexecutives which have been provided by the Industrial Associations in Cleveland and Philadelphia.

To involve real training, any course should require some work outside of the time of actual meeting. If too much work be required the course will not be successful, but real training involves more careful thought than can be given in an off-hand discussion. This refers particularly to general subjects, such as foremanship problems. Of course, more technical courses, such as a course in shop mathematics, involve preparation without question. The more discussion, the more those in training



will benefit. In one plant, a foreman, who was always known as taciturn and unwilling to discuss his problems with anybody, surprised the assemblage one evening by holding them spellbound for two hours on the work and importance of his department. Such long discourses are not to be encouraged, but this indicates how growth is inherent in subexecutive training.² Discussions should be led carefully and confined to the subjects at hand. Lectures, particularly if they are illustrated, are valuable at times, but can be overworked. Although either men from within the organization or outsiders may have a valuable point of view to present which should be included in the training, no course of instruction should be organized on this basis. Even with discussions following the lectures such a plan is likely to result in diminishing attendance, diminishing results, and no real training.

The conference method is the best all-round method of conducting foreman training.

"The purpose of the foreman conference is to stimulate individual thought, develop initiative and the powers of attacking new problems on the part of the foremen by means of informal discussions in groups of about twelve men. The foreman-conference method differs radically from the conventional teaching methods ordinarily employed. A chairman, or conference leader, presides over each group, but he is not a teacher; his duty is simply to use questions in order to develop free discussion among the members of the group and keep the discussion from deviating from the desired goal. By the conference method, foremen teach themselves.

"The conference method of foreman training is of particular value on account of its flexibility. The text material plays only a minor role, practical experience forming the background for every discussion."²

The more intimate the subjects of discussion, the more valuable will be the results. The accompanying chart (Fig. 108), illustrates the type of subject which makes for progress. It was worked out during a conference of foremen at the plant of the Everett Pulp and Paper Company, Everett, Washington. It represents the amount of supervision, on a scale of 10—as complete, that should be exercised by the foreman over the operations performed by the digester man in the pulp mill. The heavy line connects the amounts which the particular foreman thought were necessary before discussion, and the dash line connects the amounts which were finally agreed upon by him as correct after discussion and argument. Such meetings, if properly led, will result in real foremanship training.

In addition to material relating to the functions of foremen and the manner of handling their work, general material on economics, the policies

² Bulletin of Engineering Extension Division of Pennsylvania State College.

and history of the company, and problems of the industry are introduced in the most complete training programs.

Supervision of training. In large plants, all training may well be placed under the direction of a supervisor of training, who may report to the director of personnel. In smaller plants, direction of training will probably be placed under the employment department or the service department. At any rate, it is largely a personnel function, although it deals so intimately with production. In it are involved numerous major relationships of the management and the workers, including fitness for the job, promotion, and interpretation of plant policy. As such, it is primarily a personnel function, at least, to the extent of follow-up. Actual instruction may well be in charge of the actual production force.

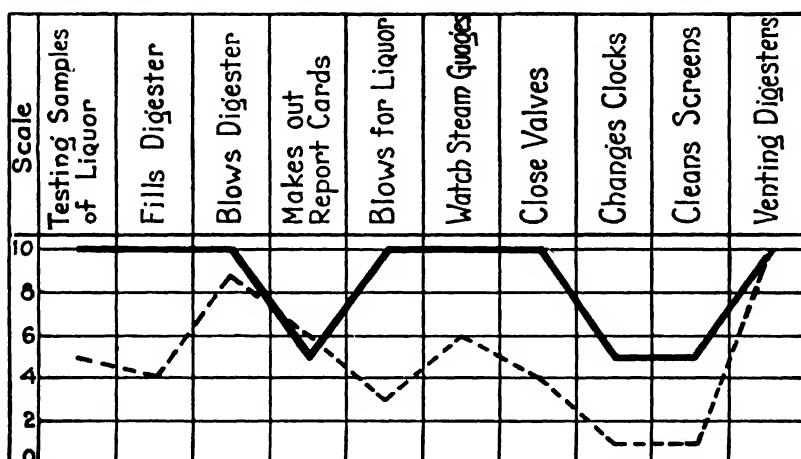


FIG. 108.—Chart Showing Relative Importance of Supervisory Duties, Everett Pulp and Paper Co., Everett, Wash.

The United States Chamber of Commerce has said,³ "There is a definite tendency to place foremanship training on an organized and permanent basis; not one course and then forgotten, but continuous from year to year. Better and more leaders are being trained for this work. Manufacturers' associations, trade associations, chambers of commerce, and other institutions are coming more and more to the assistance of the individual company. Accumulated experiences and results show that foreman training must be handled with care to produce the best results. In spite of the lack of thorough training many conference and class leaders are succeeding, due probably to natural ability. It should be remembered that a man may be a fine and thorough engineer, he may be an excellent cost accountant, yet a failure in attempting foreman training."

³ Growth of Foremanship Courses in the United States, Chamber of Commerce of the United States, p. 8.

CHAPTER XXXIII

EMPLOYEE PARTICIPATION IN MANAGEMENT

GROWING apace with the personnel movement in industry has developed one of its most important adjuncts,—employee participation. Participation has meant at times a share in the profits of the enterprise, but more correctly, and increasingly, it has meant an employee voice in the determination of management policies, insofar as they affect employee interests. To thoroughly understand the evolution of this idea in industrial operation, it is essential that it shall not be regarded wholly in the light of the structure of any one of its forms of expression. The form is not important. The basic idea is. There has never been found as great an incentive for carrying on industry as private ownership and the sense of private property owned or to be acquired. Employee participation in management seeks to extend to all members of the enterprise such a share in its operation that the urge of private ownership will be extended throughout the working force. Whole-hearted advocates of employee participation feel that workers will have no more interest in the business than the plant allows them economic interest. They feel that the solution of the destructive effects of strikes and lockouts, including the uneconomic compromised results of these, can only be found in arousing, by participation, a sense of partnership in the enterprise within the minds and hearts of all its employees.

Employee participation in profits. The first and oldest form of employee participation is direct financial participation in the profits of the business. This may come either through some developed plan of profit-sharing, or through melon-cutting at the end of prosperous years. Profit-sharing implies an agreement between the employer and the employees, under which the latter receive, in addition to their wages, a predetermined share in the profits of the undertaking over a given period. Under profit-sharing, an employee knows at the beginning of a year that he is going to secure a very definite share of whatever profits there may be at the end of a year.

The distribution of bonuses at Christmas, or other times of the year, in the attempt to share with employees the profits of the enterprise over the period, has not usually proved a successful form of employee participation. It cannot in reality be called participation at all, since the dis-

tribution of the bonus is essentially a gift from the firm to its workers. There are cases in which bonus distribution has resulted successfully, but in these the bonus is generally regarded as a portion of wages, paid in a lump sum.

Profit-sharing is often used as a means of arousing the interest of workers whose work is such that it is difficult or impossible to place them upon piece-work. Such men are executives, delivery men, men in the shipping room, and, at times, salesmen. Then again, by arousing the sense of participation, profit-sharing is frequently used for some specific purpose in the business. Thus it may be used to prevent the waste of materials, as in the case where a concern agrees to split "fifty-fifty" with its employees any saving of material which is effected by them. It is regarded by many managers as an ideal way to reduce labor turnover, by providing that only employees of a certain minimum length of service shall share, and that these shall share in accordance with their length of service. Profit-sharing becomes an ideal preventive for hasty strikes called without warning, if it be provided in the profit-sharing agreement that only those employees with continuous service shall share in the profits. Going out on strike is naturally interpreted as interrupting continuous service.

One of the main objections that employers have raised to profit-sharing is that it does not in reality involve financial participation, inasmuch as losses are not shared by those who share the profits. This unquestionably is one of the weaker points in any profit-sharing-plan, but its importance varies with the basic thoughts which have prompted the plan. Thus some employers have come to feel that there is a wage for capital, just as there is a wage for labor, and that, in justice, all above a certain wage for capital should be distributed between capital and labor. Under this assumption, there would be no cause for workers to share in losses, provided only that some provision were made for their repayment prior to the workers again beginning to share in the profits.

An example of a successful profit-sharing scheme is that of the Arco Company of Cleveland, Ohio, manufacturers of paints, varnishes, and enamels. Their plan has been developed on the idea that the share in profits should be wholly apart from wages or salary, except that these may be taken as a basis for apportioning the amount distributed. Employees participate after one year's continuous service, at the end of which time the company pays into a fund, to the credit of the employee, a sum equivalent to 5 per cent of the salary or wages (not in excess of \$3000) received by him during the twelve months immediately preceding. After the first year of continuous service, the company increases each year by 1 per cent the amount of its contribution until 10 per cent of his salary, not in excess of \$3000, is reached, with the proviso that the employee pay into the same fund an amount equal to 5 per cent of the wages or salary

paid him during the previous year, but not over \$150. Thus the company pays at least 5 per cent as a share of profits to employees of over one year's standing, and will pay an increasingly greater percentage for the next five years, provided the employee also pays into the fund a share of his salary. All moneys paid into the fund can be withdrawn by the employee, without question, after ten years of continuous service, or after three years by a woman employee who leaves to get married. Employees leaving before this time may withdraw all their contributions to the fund and in addition certain percentages of the company's contribution, ranging from 55 per cent after the first year to 95 per cent after nine years, the percentages between increasing by 5 per cent each year. Thus, length of service is one of the most important factors in sharing the profits. Profits are further shared by the investment of the funds available through this plan in the stock of the company, and the payment of dividends to the owners thereof.

Employee stock-ownership plans. This feature of investing profit-sharing funds in stock of the corporation is coming to be one of the more usual features of profit-sharing schemes. It thereby leads to direct participation in management. Any such plan must be carefully guarded and explained to employees concerned, particularly as regards possible decline in market value of the securities. Furthermore, unless the number of shares which a given employee may own is considerable, the plan tends to become one for investment of the surplus funds of the employee, rather than one of participation in management. This is indicated by the tendency of employees to sell stock, if it be in their control, at times when the market begins to decline. Stock-ownership plans are more successful as means of participation among salaried officers than wage-earners, as these are usually better able to see and understand the benefits and are usually in a position to own sufficient stock to arouse their enthusiasm for the scheme.

Employee representation—works councils. Real participation in management can usually be achieved better and without any "strings" by some form of worker-representation than by any form of financial participation. The object of employee representation is to substitute co-operation in operations for the antagonism that has been frequently felt necessarily to underlie employer-employee or management-employee relationships. Co-operation can be achieved frequently without employee representation, but this is presumed to furnish a condition wherein co-operation is enforced on both sides. It provides a condition wherein either side will perforce get co-operation out of their relationships with the other, if they put it in. Usually co-operation follows confidence, and confidence comes easily if management shows representatives of the workers that both it and the employer have the interests of the employees at heart. It

would certainly not be advisable until the works council had been in operation for a long time and an experienced group of workers' representatives, who could appreciate the manufacturing and economic conditions involved, were members. Works councils may well consider routine matters relating to production, such as quality, scrap, safety, and general working conditions, when there are no grievances or special matters for attention at the meetings. To be effective there must be regular meetings and not meetings called at long intervals, and these subjects form a satisfactory fill-in for the discussions.

Types of works councils. The three main types of works councils which are utilized are the "industrial democracy" type; the "shop committee" type and the company union. The industrial democracy type of works council attempts to apply to industrial organization a method of passing laws and settling policy which is similar to the organization of the Federal Government. There are ordinarily three bodies provided as parts of the works council under this type. First there is the House of Representatives, which is composed of representatives of the workers, then there is the Senate, which is composed of representatives of foremen and department heads. Finally there is the Cabinet, or representatives of the employer, usually major executives. Matters to be settled may be brought up first in either the House of Representatives or Senate, in the form of a bill, and after the bill has been passed by both houses, it goes for approval to the Cabinet, where it may be accepted or rejected. If rejected, it goes back to the house which originated it for revision or abandonment. It has the advantage of clearly bringing in the department heads in the formulation of any decision, but is very unwieldy, and has sometimes been installed in a way which indicated that the firm was turning over considerable power of administration to the employees, which, in fact, is not the case, inasmuch as final veto rests with the employer's direct representatives. It has been discontinued in many plants where it has been set up and a simpler plan substituted.

The shop-committee plan involves the selection of certain members of the works council by the employees and selection of certain members by the employer. These members usually sit together and their decision is usually final. If they fail to reach a decision, the conditions of the plan usually provide for an appeal either to a major officer of the company or to a neutral arbitrator. Under this plan there may be one committee for the whole plant, or there may be departmental committees selected by the workers of given departments. Departmental committees consider minor matters, such as grievances, with representatives of the employer, and select workers' representatives to sit on the works council, which is an appellate body for such minor matters and a body of original jurisdiction in the more important matters that are considered. The one-committee

plan is utilized in most small plants and many large plants, such as the Colorado Fuel and Iron Company (who have a general council composed of workers from the several plants). The divisional committee idea, coupled with the main shop committee, finds preference at large plants, such as the plant of the General Electric Company at Lynn, Mass., which was one of the first to establish shop committees in the United States.

This type of works council has come to be termed the "company union," inasmuch as it is organized to give the employees of a single company the advantages of representation in matters affecting them for which unions were first formed. Such works councils have been the means of employer-employee contact most favored by that section of American employers who operate what is termed the "open shop." Naturally such councils are opposed most bitterly by organized labor, since they have been developed partially as a means of preventing organization among employees.

Operation of works councils. The exact organization, qualification of voters, term of office of representatives, number of meetings, and other routine matters will naturally vary with the necessities of the particular organization and with the desires of those forming the works council. There are, however, some general conditions which seem to be tried and applicable in almost all cases. Voters for employee representatives must usually have been in the employment of the company for a certain specified period, usually about three months. Employee representatives' qualifications are well illustrated by the provisions in effect at The Inter-type Corporation, Brooklyn, N. Y.: "Every qualified voter twenty-one years of age or over, who speaks and writes the English language and has been continuously in the Corporation's service for one year prior to election shall be eligible as an Employee Representative from the department where he works." The term of office of representatives is usually a year, with provisions, such as those at the White Motor Company, Cleveland, Ohio, which cause the elections to be held at different times, and thus make impossible the entire overturn of a committee at once. Meetings are held at periods varying from one week to a month.

Most plans call for an equal division of voting strength between the employees and the employer in all cases except the industrial democracy plans, where this same feature is provided for in another way. Usually it is necessary to pass actions by more than a mere majority vote, sometimes by a two-thirds or three-quarters vote. This provision makes for permanence in the decision reached, but it also causes a certain number of cases not to be settled by the works council, and thus makes important the final authority. Regardless of the provisions for final authority in actions of the works council, it is necessary that the general management keep itself informed of what is going on and take an active interest in

the proceedings. If this does not occur, the works council is bound to fail. If the general management does appear interested in what is going on, the members of the works council are likely to see the importance of their position and their work, and are likely to settle cases in a manner which is more satisfactory to all. Final authority is sometimes lodged with a member of the general management, this being the most usual method. At times final authority is lodged in some previously agreed-upon arbitrator, such as the department of labor of the state, the state chamber of commerce, the Department of Labor conciliators in Washington, or some local person who is respected by all parties. If such final agreement is lodged in an impartial arbitrator, some schemes provide for a previous consideration of the case by a representative of the general management of the plant. If his decision is not favorable to the workers, the appeal to the arbitrator can then be made. In all cases where an appeal to an arbitrator is made, his decision is always regarded as final.

It is clear that a works council will not be effective if it be organized in times of stress, when the workers are dubious of the attitude of the management and perhaps are about to strike. The workers naturally become suspicious when they see the shop committees being organized at such times because of an overnight zeal on the part of the employer for "industrial democracy." The time to establish a works council is in fair weather.

Many managers have said that what the worker wants is not a partnership in the enterprise. What he wants is to be able to be certain of steady work at fair wages, with an opportunity for advancement. If he is given this, these managers say that he makes no demands on them for representation or participation in management. If a manager is sure of this, and if he is conducting his business in a way that attempts to make things fair for both the worker and the employer, it is very probable that, as yet, in that plant, it would be unwise to try the formation of a works council, and far wiser to continue the broad-minded policy of management along the old lines which have proved successful and satisfactory to all concerned.

Trade agreements. Trade agreements are contracts which are drawn up between an employer or a group of employers with an organized labor organization, covering some or all of the matters of common interest. Some of the most successful instances of collective bargaining in the United States are to be found in the working of trade agreements. Trade agreements are based on the foundation of conferences between representatives of the employer and representatives of the organized employees, to discuss controversial questions, such as wages, hours, working conditions, and other basic employer-employee relationships. Any wage scale that is set as a result of such meetings will be binding until changed by mutual consent in the plant or plants covered by the agreement. The relation-

ship between the two groups of representatives becomes a contractual one, and the representatives bind those whom they represent to carry out the terms of the agreement. The fundamental consideration in the contracts is the wage, and the idea of trade agreements is predicated on the thought that the basic wages paid are largely fixed by the bargaining strength of the employer and the employee. The recognition of organized labor and its representatives which trade agreements involve is based, from the labor point of view, on the thought of equalizing the bargaining strength of the two parties to the agreement, and giving the workers as effective leaders as those representing the employer.

The background of any trade agreement is well expressed by the preamble to the Hart, Schaffner and Marx Labor Agreement, as formulated by Mr. J. W. Williams, then chairman of its board of arbitration, in 1916: "On the part of the employer it is the intention and expectation that this compact of peace will result in the establishment and maintenance of a high order of discipline and efficiency by the willing co-operation of the union and workers rather than by the old methods of surveillance and coercion; that by the exercise of this discipline all stoppages and interruptions of work, and all willful violations of rules will cease; that good standards of workmanship and conduct will be maintained, and a proper quantity, quality, and cost of production will be assured; and that out of its operation will issue such co-operation and good-will between employers, foremen, union, and workers as will prevent misunderstanding and friction and make for good teamwork, good business, mutual advantage, and mutual respect. On the part of the union it is the intention and expectation that this compact will, with the co-operation of the employer, operate in such a way as to maintain, strengthen, and solidify its organization, so that it may be made strong enough, and efficient enough, to co-operate as contemplated; and also that it may be strong enough to command the respect of the employer without being forced to resort to militant or unfriendly measures."

It is but natural that the growth of trade agreements should have occurred in those industries which were already the most highly organized; and the history of trade agreements has been the history of labor-employer relationships in those most highly organized trades. Trade agreements have been notably utilized and notably successful in highly organized industries, such as hand-blown glass manufacture, pottery and shoe manufacture, printing, and the manufacture of clothing.

Trade agreements not only provide a minute description of basic wages, hours, working conditions, rules, methods of discharge, but often cover methods of performing operations. In the settlement of disputes they almost uniformly prescribe some neutral arbitrator.

Trade agreements are negotiated through representatives of the union

who may or may not be actual workers in the plant or plants which the agreement affects, and officers of the plant, or of the trade association which represents the employers affected. Disputes are ordinarily handled by departmental or plant boards on which both the union and the employer are represented. They may then be referred to a board for the industry as a whole, or a regional board, if more than one plant be involved. Finally, there may be some method of arbitration provided. As an example of an elaborately developed trade agreement, that between Hart, Schaffner and Marx, of Chicago, and the Amalgamated Clothing Workers of America will be described.

The Hart, Schaffner, and Marx Labor Agreement. The union has in each shop a duly accredited representative who is recognized as the officer of the union having charge of complaints and organization matters within the shop. He receives and makes inquiries into complaints; and he also collects union dues. The shop superintendent represents the management in each shop. Each side has a number of deputies who have direct charge of the execution of provisions of the agreement in the interest of their principals. They have the power to investigate, mediate, and adjust complaints; and settlements made by them are legally binding on their principals. One of the deputies on each side is known as the chief deputy, and the statement of the chief deputy is regarded as an authoritative presentation of the position of his principal in any matter in controversy. The union deputy has access to any shop for the purpose of making investigations of complaints. There is a Trade Board to hear cases which are not adjusted between the deputies. This Board consists of eleven members, all employees of the firm except the chairman, five being chosen by the company and five by the union, and so chosen as to be representative of the various departments—cutting and trimming, coat, vest, and trousers. Finally, there is provided a Board of Arbitration of three members, one representing the company, one the union, and an impartial chairman. Although it acts as a court of appeal from decisions of the Trade Board, the main duties of the Board of Arbitration relate to matters of principle and the application of the agreement to new issues as they arise.

When a grievance arises on the floor of a shop, the complainant reports it to his shop representative, who endeavors to adjust it with the shop superintendent. If satisfactory adjustment is not made, the shop representative reports the matter to his deputy without disputing or arguing the case. The deputies concerned then endeavor to reach a settlement that will be just and satisfactory to all the parties in the dispute. If they fail to agree they file the case with the Trade Board, who hear all cases in the order of filing. All decisions of the Trade Board may be appealed within ten days to the Board of Arbitration. If agreeable to

both parties, these appeals are frequently heard by the chairman alone. The majority decisions of this Board are binding, but a rehearing may be granted on demand if the Board desires. The chief deputy of each party to the agreement is held responsible for the enforcement of decisions.

The agreement covers the following main points: rates, including piece rates, which are made and changed by a rate committee of the Trade Board; hours; overtime; preferential shop; working conditions; discipline; transfers; and layoffs. The agreement provides for a preferential shop. Whenever the employer needs additional workers, he first makes application to the union. If the union is unable to supply the necessary help, the employer may secure it in the open market. Should it at any time become necessary to reduce the force, the first ones to be dismissed are those who are not members of the union in good standing.

This company contributes to the unemployment-insurance fund maintained jointly by the Chicago Industrial Federation of Clothing Manufacturers and the Amalgamated Clothing Workers of America. The employees contribute $1\frac{1}{2}$ per cent of their wages to the fund, and the employer contributes an equal amount. Benefits are paid to 40 per cent of weekly wages, not in excess of \$20, with the maximum payments not exceeding five weeks' benefits in one year.

Trade agreements are frequently much more narrow in scope than the one just described, while many fully developed trade agreements have been signed in recent years. Among the outstanding ones may be included those of the Baltimore and Ohio Railroad, and its shopmen; the Cleveland Garment Manufacturers' Association, and the International Ladies Garment Workers' Union; and the Employing Printers and the International Printing Pressmen and Assistants' Union.¹

Future of trade agreements. As the number of successful trade agreements increases, it is probable that the number of such agreements in organized trades will grow rapidly. With experience in their operation, it may be confidently expected that better administration of agreements will become a fact of the future. This will include a broader view by the union of the necessities of industrial management and operation, particularly in securing economies of production, and a broader view by the employer of the aims of the union. However, trade agreements are only applicable to trades which are highly organized and to plants within those trades where the workers would rather deal through their union representatives than directly with employers through works councils or some other form of intra-company collective bargaining. The individual plant, in most industries, which maintains the confidence of its employees, and particularly, which makes the wages and conditions of work equal to or better

¹ For plans of works councils and trade agreements see "Political and Industrial Democracy," W. Jett Lauck, Funk & Wagnalls Company.

than the union standard, will probably continue to operate smoothly and in successful relationship to its employees without the use of trade agreements, or even without the development of any form of works council, except possibly a very loose committee organization. But such operation can only be based on a broad, intelligently developed basic personnel policy which has been formulated squarely on the idea of the development and continuance of good-will between the firm, the management, and the workers.

CHAPTER XXXIV

ORGANIZED LABOR AND MANAGEMENT

THE attitude of organized labor to modern industrial management has changed very greatly in recent years. At first actively hostile to some of the fundamental principles, organized labor now heartily indorses and takes as its own basic policies some of those management ideas which its earlier leadership fought. Because of the organized employer opposition to anything that savors of organized labor in some of the most basic industries, labor in those industries has been engaged in endeavoring to secure a foothold. But in those industries which are sufficiently organized to support trade agreements, it has been seen that organized labor and management are now progressing hand in hand toward lower production costs.

Early organized labor opposition. The early opposition of organized labor to modern management's principles and devices was partly based on economic principles, since repudiated, and partly on a misunderstanding of its basic concepts, due to the improper wording of the first scientific management writings. Notwithstanding his many denials, it is probable that most union leaders who were contemporaries of Frederick W. Taylor thought that he was an enemy of unions. In Taylor's day, many unions favored restriction of output, to which Taylor's whole life was opposed. To-day organized labor in the United States agrees that in increased output lies the opportunity for higher wages.

It probably was due to the fact that scientific management first developed in unorganized trades that union leaders of the time feared it, and endeavored to destroy it. They particularly attacked time study as the device which they claimed was symbolic of the attempt of scientific management to destroy skill and initiative. Against time study organized labor made a great drive in Congress in 1912 at the hearings before a special committee of the House of Representatives "To Investigate the Taylor and other Systems of Shop Management." Stop-watch time study had been adopted in the arsenals of the Army Ordnance Department through the leadership of General William Crozier, Chief of Ordnance. It is probable that there were more workers working under rates set by time study in the Government arsenals in 1912 than in any other enterprise. However, it was the example of the use of the stop-watch in the new and unorganized automobile industry that led the unions to try to destroy its use nationally by prohibiting its use on Government work.

It was during these hearings that Taylor was put on the stand and said, "Do not understand for a minute that I am opposed to trade unions. . . . I am in favor of them. They have done a great amount of good in this country and in England; I am heartily in favor of those elements of trade unions which are good. . . . I believe that the unions are misguided in a few respects. . . . One of the worst principles of the trade unions. . . . is that it is to their interest to deliberately, purposely work slow instead of working fast, with the object of restricting output." Taylor's attitude of yesterday has become the attitude of enlightened union leaders of to-day.

The objections of labor to time study. Many of the objections that labor has held against time study have been justifiable, in view of the methods that have been used in some companies. In cases in which the management has wished to engage in time-study work on a scientific basis, they have been unjustifiable. The objections of labor to time study may be classified under these main headings: objection to its effect on the status of the individual workers; objection because of its effect on basic union policies; and objections because of defects of method.

Effect on status of individual workers. It has been pointed out by many workers that to take time studies of a worker is, in a sense, an evidence that management is suspicious of the fair intentions of the worker to turn out a fair day's work. It is explained that management would never think of taking time studies of executives in the performance of their jobs, but that more opportunity is usually afforded for bettering their output than for bettering the output of the worker. As in the case of most other objections, the only possible answer to this depends on the methods of taking the study, the extent of co-operation of the worker himself, and the benefits which the worker achieves.

It is also pointed out that time study is destructive of the worker's skill, inasmuch as it substitutes the skill of the management for the acquired trade skill of the worker. Not only may this result in the degradation of the worker, but it is to be questioned whether it is desirable from the broad social standpoint to allow one small class in the industrial community to have all the knowledge concerning how jobs should be done. In this connection, job study is frequently referred to as a means of making the worker a portion of the machine, that portion which has not as yet been cast into steel, and thus repressing his initiative. It is pointed out that after job studies, workers must conform to the methods of others.

Labor organizations have frequently pointed out that the pace which results from the taking of job studies may be destructive of the worker's health, in that it extracts his last ounce of energy and reduces his vitality. The fact that individual workers may be favorable to working under job studies, it is pointed out, does not necessarily mean that it is for their individual good. They may be thinking only of the pay envelope of the

week or of the month, whereas it is desirable that somebody should be thinking of their future in the industrial community, and considering what their general vitality will be after some years of working under the pace which has been set. One of the strongest points in this connection is the method utilized in setting fatigue allowances in many organizations. Clearly to overcome this objection to time study, it is essential that some definite attempt be made to study fatigue as applied to the jobs in a given shop, and to insure that the fatigue allowance is large enough to cover cumulative fatigue over a period of years.

It has frequently been said that, although rates under job study may be guaranteed, nevertheless time study becomes a method of cutting wages. The reasoning is that the reservation is always made, on guaranteeing wage rates, that a change in the method of operation may result in a change in the rate. Since the method is so clearly and closely detailed by the result of job study, it becomes exceedingly simple in some slight degree to change the operation. This change may be brought about because of the high wages which workers may have been getting through close application to their work under the assurance that rates will not be cut; but the operation is slightly changed and the new rate which is set may be sufficiently below the old rate to make it necessary for the worker to apply himself at the pace he has achieved and, at the same time, to get wages which are considerably lower. Again, the only answer which can be made to this objection is that no management that wished to continue job studies over a long period of time, or wished to maintain good relations with its employees, would ever attempt any such practice.

Time study is opposed to fundamental policies of trade unionism. Trade unionism is, of course, based on the idea of the development of class consciousness among workers as a group. This is necessary in order to combat the superior economic position of employers, particularly organized employers. Time study, which results, to an extent, in competition between the abilities of individual workers, naturally has a tendency to break down this class consciousness. This is particularly true inasmuch as the rates based on time study ordinarily are piece rates or some variation of these. Most unions have not been very favorable toward piece rates.

It is probably true that a study of jobs within an organization has a tendency to knit the organization into a unified whole of management and workers, all striving to better the general condition of a particular plant rather than any particular group in industry as a whole. In so far as this is true, it is but natural that organized labor should look with some degree of alarm upon time studies, particularly since this violates one of the basic ideas behind the development of unions.

Objections to the time-study method. The third type of objections of

labor deals with defects in the method itself. It is necessary to state this because these defects must be frankly admitted in many cases, and the only question is whether, despite these defects, the advantages of job studies are not sufficient to justify their existence. Again, the importance of these defects is largely dependent upon the general attitude of the responsible management of the organization.

Briefly stated, some of the objections based on defects in method are as follows: Since time study is so dependent on the ideals of management and of the observer, it is unwise for labor to lay itself open to the possible results which may follow. Although a particular observer or a particular management may be, at a given time, broad in spirit and in action, nevertheless it can never be known when the management will change, either in personnel or in spirit, and the results of the job studies may be used as a club over the worker, rather than as an aid to him. Again, the results of time study will vary in accordance with the degree of standardization which has been achieved. This relates not only to standardization of materials and machines, but to the weather conditions at the time that the study was taken. It cannot be expected that the worker will continue the year around at a pace at which he may have been timed under the best possible weather conditions. The manner in which he is allowed to work is also an important variable, and, although it may be presumed, under the best methods of taking time study, that the observer will be careful to insure that the worker does not reach a pace which cannot be maintained over long periods, nevertheless there is no assurance of this. This is particularly important in cases where a number of workers are engaged on one operation and only one worker is studied. Finally, methods of working up time study at best are arbitrary. The elimination of abnormal times, the determination of selected times, and the setting of allowances are all wholly at the discretion of the management. The worker who is being observed has no control over these whatsoever, and no worker in the plant has any control over them. Inasmuch as the final task set, and hence the wage rate, is more directly dependent upon these than it is on the observations which were taken, it follows that co-operation of the workers in the taking of time study may become merely a pleasant fiction.

The methods used by many companies in the early days of time study, and to some extent to-day, have justified these criticisms. Unfortunately, many of the first attempts to apply time study were used merely to secure greater output from the workers, without any thought of permanent effects.

Unions and time study to-day. It is in the clothing industry, as a result of trade agreements, that organized labor to-day utilizes time study to the greatest extent in rate-setting. The United Textile Workers and the employers in the garment industry of Cleveland take joint time studies to

assist in fixing rates. Mr. Sidney Hillman, President of the Amalgamated Clothing Workers, has long been an advocate of time study as a method of determining relative rates on several operations. Many leaders of organized labor have not brought themselves to endorse time study, because of its misuse, but they have endorsed a decrease of production costs. They have come to see that high wages can only be paid by lowering labor costs.

Unions and low-production costs. Basic trade-union utterances with reference to employer-union co-operation have already been noted, on page 28. William Green has said,¹ "Labor realizes that the success of management means the success of labor. For that reason labor is willing to make its contribution to assist management and to bring about the right solution of problems dealt with by management. . . . Management is understanding more and more that economies in production can be brought about through the co-operation of labor and the establishment of high standards rather than through autocratic control and the exploitation of labor. Labor is understanding more and more that high wages and tolerable conditions of employment can be brought about through excellency in service, the promotion of efficiency, and the elimination of waste."

A Conference for the Elimination of Waste in Industry was called by the Labor College of Philadelphia and the Central Labor Union of Philadelphia on April 9 and 10, 1927. This conference, drawing union leaders from all parts of the country, marked a new page in labor-management history. It was addressed by leaders of labor and management, and the dominant note was set forth by President Green, as follows:² "Economies in production are a concern of all who have a part in the work and who may benefit from increasing the margin between costs and selling prices. Initial responsibility for efforts to reduce or eliminate wastes rests upon the management, while unions contribute to the development of plans and in putting plans into production procedure."

At the Waste-Elimination Conference, Mr. Gustave Geiges, President, Full-Fashioned Hosiery Workers No 706, gave an address which typifies the attitude of the new union leadership toward modern management. He said in part:³ "Wages in the full-fashioned industry probably will average higher than in most industrial occupations to-day, but the labor cost of a pair of stockings is low. The proportion of the cost of a stocking which goes into labor is about 25 per cent of the price at which the manufacturer sells his goods to the wholesaler. . . . It is vitally important that goods of the highest quality be turned out in the full-fashioned factory in order that the highest profits be realized. . . . If the knitter is making good stock-

¹ Labor's Ideals Concerning Management, by William Green, President, The American Federation of Labor, Bulletin of the Taylor Society, Vol. X, No. 6.

² American Federationist, Vol. 34, No. 6, p. 664.

³ *Ibid*, p. 668.

ings he is also making a lot of them, and, therefore, is making a good wage. And when he is making imperfect work he is losing money just as well as the manufacturer is losing money. . . . That efficiency and waste elimination really pay in our industry has been proved to the satisfaction of many. Those concerns, such as the Phoenix of Milwaukee, and the Gotham, Lehigh, and William Brown companies of Philadelphia, which are among those concerns making the highest profits, are firms which co-operate with the union, and which often pay above the union scale of wages in their different plants. . . . The official policy of our organization is to encourage capacity production, although, of course, we stress the fact that the worker must not speed up to the point where he produces a contrary reaction on his health. . . . We have gone into certain shops . . . where production has fallen off. We investigated and found out why our people were not doing their best work and we stimulated the sense of workmanship in those groups of workers who had become indifferent for various reasons. Production in all cases increased. . . . We believe that we can reduce waste of all kinds most effectively by developing an understanding among the workers in the industry that proper use of material and sense of responsibility in each and every worker in the full-fashioned hosiery industry toward his industry and his union will bring about an enormous conservation of human effort and expensive material, at the same time cutting down running costs and adding to profits and wages."

Organized labor and company unions. As previously indicated, organized labor is opposed completely to any works councils or other bodies which may be termed "company unions." Labor unions have refused to have anything to do with works councils. In some cases, all but the highly organized departments of a plant have accepted the works council, with no representation from the organized departments, who have continued to work through the regular union officials. The 1919 convention of the **American Federation of Labor**, held at Atlantic City, condemned works councils as a delusion and a snare, "set up by employers for the express purpose of deluding the workers into the belief that they have some protection and thus have no need for trade union organization."

Maintenance of good working conditions in industry. The union viewpoint, so forcefully expressed in the above quotations, is that, while unions always carry on for the protection of the workers, favorably disposed employers may sell out, or, because of pressure, be unable further to carry out the liberal policies that they have instituted. As the years pass on, doubtless there will be an increasing number of such cases to be pointed to, although, in number, such cases will be far outweighed by the new companies pursuing a liberal and enlightened policy toward their workers. Nevertheless, the dangers which are pointed to by the unions are real dangers, to be given every consideration in the formation of works councils and pension and group-insurance plans.

PART VIII

CONTROLLING OPERATIONS

CHAPTER XXXV

BUDGETING FOR ADMINISTRATIVE CONTROL

IN the modern business world, the extent of control over operations determines in a large measure the profits of the enterprise. Control over the operation of a particular department of a business is difficult to maintain unless it is linked up with corresponding control over departments with which it must mesh in the drive toward business progress. The administrative budget provides the necessary means of supplying the co-ordination between department plans. The budget idea in business implies the thought of planning ahead, forecasting to-morrow and laying co-ordinated plans which will lead all major portions of the business along paths that will cross and diverge at predetermined points, so that the business will operate as a unified whole. Business foresight is largely hindsight, and thus administrative budgets must not only be developed by means of forecasts of business conditions as they affect the particular enterprise, but on the basis of past history, carefully interpreted. Business budgets are much more difficult of formation than are governmental budgets, since income and expenditures cannot be separated. Unlike budgeting for governmental work, a reduction of expenditures in a business may reduce the revenues directly. Thus, a reduction of an advertising expenditure may reduce the sales, and hence the income, while the reduction of a manufacturing expenditure may directly affect production, and hence the source from which income is derived. This added difficulty, which is an important practical element in the development of administrative budgets, is the most difficult of measurement when visualizing to-morrow during the process of budget development.

Aims of the business budget. Budgets are necessary for business control, since they provide for a careful item-by-item consideration of departmental programs. They become a check on unjustified optimism or pessimism of departmental heads, and they not only give a target, but a bull's-eye at which those responsible may shoot, and toward which those in charge of the major business activities may direct their control. Not

only does the budget make possible the development of departmental programs, but it is a means of saving over-expenditures in departments. To check leaks, it is necessary that they be recognized when they are seen. Preconsideration of items of expenditure makes possible the recognition of leaks, both at the time the budget is being considered and during the period of operations that it covers. The budget is also a means of eliminating the misdirection of assets through improper enlargement of facilities at the wrong time. If expenditures for plant enlargement are subjected to a careful survey of their purposes and their justification, with a realization of what they will mean in terms of expansion of sales and production, it is very likely that hasty enlargement plans will be eliminated, and assets retained to operate the plant in phases where they are already needed. Finally, the budget is an unparalleled aid in the development of a financial program. Bankers are steadily and increasingly demanding more knowledge of operations and programs than formerly. They are asking for information, not alone along lines of balance sheets, character, and capacity, but along lines of prospective operations. They are desirous of knowing when loans which they may make are going to be repaid, and in this connection they want the detail of commitments, of prospective earnings, and financial conditions in a way that a budget alone can give. In increasing numbers, bankers are going to demand the submission of a budget which will definitely indicate when loans are going to be repaid, with substantiating figures, at the time that application for loans is made.

For instance, a firm doing a business of \$750,000 yearly may have a majority of its sales in the spring of the year. In order to make production nearly equal at all seasons, and to have goods ready for delivery when sales are made, it is necessary to borrow funds during those periods when sales are slack. Thus, \$30,000 of product may be produced in January, but income may be only \$10,000 from open accounts and January sales on which cash discounts have been taken. Therefore \$20,000 must be borrowed, with equal amounts through the winter months. Budgets assist the bank in determining the amount of credit which may be allowed safely at any time, assist the firm in determining the amount of loans that it needs, and allow it to promise repayment to the bank at a stated time. In this case income would exceed expenditures in April, May, and June, and during these months loans secured from the bank in the winter would be repaid, and a balance established to carry the company without further loans until the next winter.

Advantageous developments which follow the use of the administrative budget. All of the aims of the budget are achieved through the developments which always follow logically upon its adoption. There is immediately secured an unheard-of co-ordination of departments, particularly a co-ordination of the sales, production, and financial forces. This co-

ordination not only can be made general, applying to the activities of the business as a whole, but can be reduced to a consideration of particular lines and items. Departmental schedules can be set up which will detail the lists of expenditures, with their relation to the various items of product, as well as to the business as a whole. Costs can be collected in a way that will mesh with the developed budget, and they may be used as a means of control, which is their logical field, rather than as history. Finally, a financial program may be developed which will act as a chart to the pilots of the enterprise.

The budget eliminates much snap judgment, such as "Overhead is too high—it must be cut," followed by a general reduction without regard to effects.

The procedure for budget making. The procedure for budget development usually starts with a preliminary conference of department heads, in which the trends of the business and of industry in general are considered, and broad lines of progress are mapped out with the aid of the general manager and others who have control of the broad policies of the business. With the results of this conference in mind, the departmental heads go back to their separate fields, and prepare budget estimates which are based on the general program that has been outlined. These budget estimates are usually submitted to one officer of the company who has been chosen for the purpose. This man will ordinarily be the comptroller or the assistant to the general manager. In small businesses he will be the general manager. He suggests changes to the department heads, based on his knowledge of basic factors, and with an idea of coordinating the activities of the various departments. With this in view, he may call conferences of two or more of the departmental heads, whose estimates must depend on each other and who may seem to be furthest from agreement in their first estimates. When such matters have been adjusted to the fullest degree by this means, the general budget meeting is called, at which time each department head submits his budget, and must meet the criticism and comment of the others present. Although final control of the budget estimates must necessarily be left in the hands of the president or general manager, this budget meeting will ordinarily largely determine the final status of the budget requirements and estimates of the various portions of the business. When finally determined, the budget should be prepared in a satisfactory form and distributed to all interested persons, in order that they may know definitely what is expected of them.

The budget officer, as he develops his major plan, must determine first the desired profit, after which he will consider means of earning that profit. The gross profit must be sufficient to meet all depreciation allocations, any needs for expansion programs and increased working capital, and in addi-

tion, the fixed charges and dividends. After gross profit has been determined upon, the amount of sales volume to produce this profit must be determined. This involves full consideration of selling prices, production costs, and individual profits on each item of production.

Methods of making up departmental estimates—sales department estimates. If the preliminary budget has accomplished its purpose, it is probable that most of the budget items will be settled, at least as far as their major outlines are concerned, in the development of the departmental estimates. The sales-department estimate will include a full statement not only of necessary expenditure, but of probable sales and shipments during the budget period, subdivided by kind and unit value as well as by total value. The estimate of shipments is equally important with that of sales, as upon this will largely depend the time when cash receipts may be expected. This estimate must be based on a consideration of past history, as well as a full consideration of the seasonal factors that may be involved, business and competitive conditions in the industry, the obsolescence or style factors which may be present, traffic conditions, and the relation to the manufacturing program, both as regards production needs and the extent of unfilled orders. An important consideration is the available demand at various selling prices, with the margin of profit that is left under each condition. The cost of securing large volume, with full data from the manufacturing departments, will in a large measure determine the output that the sales force will attempt to sell. In taking into consideration these factors, the first step should be a careful charting of sales during the past, with an investigation of causes of irregularity. Trade association reports, reports of salesmen, and forecasts of general business conditions must then be studied, and a conclusion reached as to whether sales are likely to advance or recede from the normal amount of the period, after which sales may be estimated for the budget period. This estimate is basic in much of the budgeting work of this and other departments, and should usually have been largely determined in the preliminary budget conference. The trend of raw-material prices must be carefully observed and studied if these estimates are to approximate what the experience will be.

Manufacturing department budgets. If standard articles are being manufactured, the number in each unit of time during the budget period may properly form the basis of the manufacturing budget, with all expenditures dependent on this. If, however, the concern works to customer's order, or is largely influenced in the exact amounts of different lines or styles that it manufactures by the day-to-day demands of the market, it is probable that the manufacturing schedule must be worked out in terms of units of material or of cost. The manufacturing budget must be determined not alone from the estimated sales, but from the requirements

of the manufacturing departments. That is, the attempt must be made to run the plant on as even a keel as possible the year round, and the manufacturing budget must be developed with this in mind, as well as the sales-department estimates and the financial requirements of the plant. For, regardless of the desirability of equalizing the production program in the various months of the year, this may not be entirely possible because of the style or obsolescence factor, or because of the financial inability of the concern to carry the amounts of materials and labor costs which would be thus tied up for months under such a program. It is here that close co-ordination is necessary between the manufacturing and the financial departments, in order that every effort may be made by the latter so to finance the business that the manufacturing department may get all the advantages in lowered unit cost that are inherent in steady operation throughout the budget period. The unit costs of production under varying amounts of production need to be closely studied by the manufacturing executives in order that they may intelligently make recommendations concerning the spread of the manufacturing program over the course of the budget period. They must be in close consultation with the purchasing agent, who, through his knowledge of the state of the material market, should be able to advise intelligently with regard to the probable trends in material costs, and with regard to the advisability of tying up large amounts of the firm's capital in material, partly finished or finished product, on which return will not be secured for some time.

The estimated payroll can best be determined on the basis of the prospective production by carefully analyzing past payrolls at various points of production, and from these figures making allowances which are based on changes in wage rates or on changes in production effectiveness. A consideration of additional payroll costs due to overtime work, or due to the necessity of adding to the overhead, will often serve as a means of stopping sales-expansion programs which otherwise look good, with the additional costs of manufacturing to reach that program eliminated.

Among the factors which assist the manufacturing department in working up their budget are the following: development of supplementary products which will make possible a balanced production, fully utilizing equipment; the desirability of manufacturing or purchasing components; facilities for storing materials; and a consideration of production costs of varying outputs.

Service department estimates. The budgets of the various plant service departments, such as traffic, shipping, and stores, may be included in the general manufacturing budget, or they may be developed separately, inasmuch as, like other service functions of the factory, the amounts of outlay are more or less constant, regardless of the manufacturing program.

The budgets of the general business service department, the general office and the personnel department, should be prepared in a simple and easy of preparation by the heads of these respective departments.

The financial budget. The financial budget cannot be prepared until the other major departmental budgets are in a fair way toward completion, inasmuch as it is directly dependent upon them. It should be a statement of the probable cash income and expenditures by month, with a careful analysis of the times at which the company will be compelled to borrow in order to carry on its manufacturing program, as well as the times when it may be expected that the loans will begin to be repaid, and the times at which they may be completely repaid. The credit manager of the organization will have a direct interest in the preparation of this information, and it will be his advice concerning collections that will make possible the translation of the items of shipments into receipts at a later time during the budget period. In order to be able to estimate receipts, he must be in a position to know the general credit situation and how money may be expected to come in. He must be able to advise concerning the terms of payment that will have to be permitted, and the extent to which it may be expected that the regular terms will be lived up to. In addition to this he must be able to advise the times at which overdue balances will be liquidated. This information will largely give the basis, together with the sales department estimates, of the expectancy in receipts. From the other budgets, cash outlays must be determined through a consideration of such separate items as materials, direct labor, overhead expenditures, administrative and selling expenses, state and Federal taxes, fixed charges and betterments to the plant. With the close analysis of all these items will come the possibility of formation of prospective balance sheets for various times during the forthcoming budget period.

With the final development of the financial budget, the budget picture of the business may be considered to have reached completion, and the various budgets of other departments may be looked upon as subsidiary in the formation of the financial budget.

Length of the budget period. While the length of the budget period cannot be definitely stated for all industries and all plants, care must be taken, particularly in the beginning of budget development work, that the period does not extend beyond the time of accurate forecasting. It is necessary that some arrangements be made for periodical revisions in the budget, for reasons that are apparent, but which will be briefly referred to shortly. The decision concerning the length of the budget period must be dependent partially on the extent of information which is available concerning past operations. As budgets are prepared, and actual performance statistics are available to check against estimated figures, the length of the budget period may be increased. General business condi-

Business in general is stable or greatly unsettled, and the length of time that the budget estimates should cover, and the number of revisions that must be made. In different businesses, the differences in the length of turnover of moneys and the importance of the seasonal factor will partially determine the length of the budget period. The period should always be long enough to cover at least one complete cycle of seasons, provided seasonal features and manufacturing to stock in anticipation of later sales are important factors in the business.

Decisions to be taken on the basis of the budget. Budgets are very valuable in proportion to the extent that they are used as the basis of action within the business. The general administrative control which is implied through the development of a budget implies that similar lines of control will be carried through the whole business in each department. The success of the budget is, therefore, largely dependent on the extent to which each of the various departments has its work scheduled and analysed. Thus, on the basis of the approved budget, the financial department goes to the banks and makes with them arrangements concerning the borrowing of funds to carry on the program which has been adopted. The sales department sets quotas for their various lines, for their various branch offices, and for their various salesmen, and lets advertising contracts to the amounts specified in the approved budget, with a view of creating consumer demand which will enable it to sell the amount of each product that it has pledged itself for. The production department sets up general schedules of production, determines the activities of the various manufacturing departments at various times, and makes arrangements for the proper routing and despatching of the work through the factory in order that the basic schedules may be met. The extent to which such careful departmental planning is carried on will be the measure of the success achieved in the whole idea of general administrative control. For instance, even the effective setting of maxima of articles of stores may depend on the accuracy with which the budgeted amounts of inventories will be needed and, therefore, the success of the whole financial plan that has been developed.

Budgets, to be useful, must be flexible. Manifestly, if budgets are really to control, rather than become a hoped-for ideal, they must be made flexible and changeable to meet changing conditions that may occur during the budget period. There are always some factors of the future that are incapable of being forecast at the time that the budget is prepared. These factors include minor changes in general business conditions, although major swings of the pendulum should be capable of being visualized, and changes in consumer demand. Changes in consumer demand may be basic, as a change in the type of material in a fabric, or they may be style changes which change the patterns, colors, or weights of a fabric.

Changes in sales and production schedules may have to be made on account of the unparalleled favor that is given, without warning, to one particular item of line or product.

Limitations of budget control. Budgeting for administrative control has certain limitations which must be frankly recognized if disappointment from its use is to be avoided, and if the benefits which may be derived from it are to be secured. In budgeting, it is a slow process to approach perfection, a process that involves trial and error. The more frequent the trials, the fewer will be the errors. This must be understood by all executives, major and minor, or the budget plan is likely to fall into disrepute. Even if the budget figures are not capable of being fully lived up to during the first few years, the advantages gained from a careful consideration of all factors influencing the trend of the business, and the advantages of having the major executives sitting around with each other, with all the cards of their various departments on the table, should not be overlooked.

It must be understood thoroughly that budgeting cannot take the place of adequate executive control of operations, but is only an aid toward this. The effectiveness of the budget is directly dependent on the effectiveness of administration within the several departments. It is an influence which should lead to better executive control, but which can never replace it.

CHAPTER XXXVI

OPERATING THE BUDGET

REPORTS to the general manager form the basis of his control of expenditures during a budget period. He should have information available at all times as to the percentages by which each department is bettering or exceeding its quotas. If the operation of the budget is to be effective, he should question constantly figures that are appreciably out of line in either direction. Department managers must maintain similar checks on operations and expenditures within their departments. If department budgets are controlled effectively, there will be but little need for action on the part of the general manager or his budget officer.

An alternate budget may be prepared at the time that the budget is adopted, and may supersede the one that is rendered out of date by changes in conditions. Such budgets may be prepared departmentally, and, without further word, if departmental activities vary by certain percentages, the departments know the percentage by which they should increase or decrease their expenditures. If the costs of basic materials or of direct labor vary by specified percentages, definite predetermined authority may be likewise given the production departments to increase or decrease their expenditures in definitely stated proportions, and similar authority may be given the sales department to vary their estimated receipts from sales. It is usually more practical, however, to call for revisions of the budgets when basic conditions change. The only danger in this is the possibility of department managers being given a loophole through which to escape if they cannot meet their announced budgets, regardless of whether there be a fundamental change in conditions or not.

Control of departmental performance. Each department head must make plans to have his subordinates work toward the budget in a routine way that will require but little supervision from him. The accounting department should set up a budget accounting procedure which will provide for setting up an account for each budget allotment, and then posting expenditures under that allotment to that account. (See Fig. 109.) Such sheets as that illustrated should be checked constantly by a budget clerk in the accounting department, and this clerk should notify department heads when allotments seem to be in danger of being over-

tion of a few cents on the jobs of a number of workers for a number of days will make a great difference in labor costs over a budget period.

Labor budgeting is an essential element in the budgets of every department in a business. In order to predetermine costs over a period, it is necessary that some estimate of personnel costs be made. The payroll budget must show the number of dollars that will be applied in wage increases, in the savings incident to high-cost workers leaving and their places being filled with newcomers at lower rates. This is one of the most difficult items in budget preparation, and it is more difficult to administer it within the limits that have been set down. Departmental executives must distribute the budgeted payroll in such a way that total labor costs for the department will be within budget estimates, and at the same time wages must be changed to conform to daily requirements. The

DEPARTMENTAL DIVISION.....		ESTIMATE NO.					
		BUDGET ITEM NO.					
	TOTAL	LABOR	MATERIAL	TRANSP.	COMM.	SUB. ORD.	
ESTIMATE							
Jan.							
Feb.							
Mar.							
Apr.							
May							
June							
July							
Aug.							
Sept.							
Oct.							
Nov.							
Dec.							
TOTAL							

FIG. 110.—Control Sheet for Use in Operating Budget.

departmental head must have his estimated payroll and his actual payroll constantly before him for comparison.

The Personnel Department must secure the labor budgets for the several operating departments, and make arrangements to have the necessary number and type of personnel available at such times as the prospective manufacturing schedule indicates is necessary. Sufficient personnel must be hired to provide for the high mortality rate that occurs, even under the best conditions, immediately after hiring, and such personnel must be available in time to be trained when needed in the schedule. A study of the factors influencing the turnover of labor in the several departments must be made at the beginning, and constant check must be made throughout the budget period to see that actual turnover has compared favorably with budgeted turnover.

Major business control. As the budget period progresses, the general manager must have accurate reports of operating conditions within the business. It is on the basis of these reports that changes in the budget will be made. Periodic reports, monthly or semi-monthly, will inform him of the profits and sources of profits within the last period. These reports will be compared with past periods, and with the budget. Such reports will include a statement of earnings, operating expenses, and profits for the month. An income statement will be included which will be divided into budget accounts. Major expense headings will be given for each department, with comparisons with the budget.

Current analysis of business conditions. With the reports before him, the general manager may call his advisory committee to consider the major trends which they indicate. On the basis of their knowledge of business conditions, and that of any statistician or other advisory man who may have knowledge of business trends, decision is made as to whether the budget shall continue as adopted for the remainder of the period, or whether changes or a whole new budget shall be made.

Various economic services are now available to assist in forecasting business conditions. In addition to the commercial services, some of the more important sources of information are the statistical data of the Federal Reserve Banks, the forecasts of the several university bureaus of business research, and independent statistical studies of business cycles.

The successful operation of a budget depends, above all, on successful control of the various departments of a business: sales, production, finance, and their several divisions.

CHAPTER XXXVII

CONTROL OF SALES

ALTHOUGH in too many manufacturing establishments the sales department has held the balance of power to the ultimate detriment of the whole enterprise, nevertheless, it is the sales department which brings the orders that allow the business to survive. Even the most effectively organized manufacturing departments can show no results unless a steady stream of orders is being entered on the books of the company, and there are few products, no matter how high-grade they may be and at what low cost they are produced which in reality "sell themselves." So, particularly in buyers' markets, the continued prosperity of a business must rest largely on the ability and effectiveness of the sales force, and the ability with which this is directed. As a factor in operation, the technique of sales and advertising is extremely important. However, this technique represents the findings of sciences almost as highly developed as those which govern the manufacturing organization and process, and cannot become a subject for adequate consideration here. Our discussion must necessarily cover sales only from the administrative and co-ordinating standpoints and in its relation to other major functions of a business, particularly production.

Direct control of the business over the sales function must be assumed. That is, though there may be jobbers in the scheme of product distribution, these are assumed to be links in the distributive process rather than to be in a position to control the business policy. Any manufacturing enterprise which places itself in a position where its distributors may dictate what shall be manufactured and when this shall be turned out, is in a very precarious condition for long and prosperous operation. Particularly in certain textile lines, selling agents have dominated manufacture to this extent, and a usual result has been that the manufacturing plant has sooner or later been taken over by the selling agents, after which time a policy of co-ordination rather than of dictation has been instituted. There is thus assumed, in the discussion of control of sales, a sales manager who shall have actual control over the means and methods of distribution; as well as responsibility to the general management of the business. This sales manager, although full of enthusiasm and drive, and with the ability

to go out and get business in the old-fashioned way, must also be cool and calculating and able to plan and direct the efforts of his subordinates, as well as to co-ordinate their efforts with those of the production and financial staffs.

The sales manager's function. Co-ordination of sales effort with the efforts of the manufacturing departments, with the engineering or design staff, and with the financial program of the business was seen in the chapters on budgeting to be a prime requisite for orderly administrative control of the major program of a manufacturing establishment. It is the development of the sales schedules of this master program and the administration of the developed schedules that we are considering now. The energies of the sales manager, in addition to his constant drive actually to sell what is being produced or will be produced, are partly taken up with thoughts of new lines of product to be developed. The design staff may be called upon by the general management to create some new product that can be produced at a given price, or that will meet some new demand of the market, but it is the sales manager who will have to pass on the practicability of the product from the selling standpoint, on the desire of the market for given products, or on the power of the market to absorb new products. In considering these conditions, the sales manager keeps constantly in mind the necessity of meeting changing consumer demand, the creation of new demand which will be directed toward all or some of the product of his particular plant, and the constant necessity of elimination of seasonal variation in production. It should be emphasized that all of these considerations will be of importance whether the company manufactures primarily to schedule or primarily to customer's order. If the latter plan of operation be the one followed, the principal difference will be that the sales manager's task will be much more difficult, in that he will have to sell and plan for sales in terms of the extent to which current orders fill particular portions of manufacturing capacity. Delivery dates on new orders that are taken must then dovetail with promises that have been made on orders which have already been turned over to the production departments for manufacture. If the plan provides for standard manufacture to schedule, control of sales become somewhat simpler, although the energies of the sales force must frequently be directed toward the movement of certain articles which the market suddenly rejects after the budget and manufacturing program have been developed.

Seasonal variation in production is costly from a production standpoint, and it is killing to the morale of a working force. Yet attempts to eliminate seasonal variation may be extremely dangerous if not carefully handled. Miscalculation by the sales department may tie up large amounts of moneys in inventories of finished goods from which consumer demand has shifted. Particularly in style industries is this true, and yet

in such industries the need for just such action is most important. Because of this condition, in such industries, it is best, if practical, to add lines to the product for which there will be demand in reverse seasons, or to establish certain staple lines for which there is constant demand, and which may be manufactured when style lines cannot with safety be produced. An illustration of the first plan is found at the S. L. Allen Company, of Philadelphia, which has combined sleds and farm implements. The Dennison Manufacturing Company, of Framingham, Mass., noted for constant operation with products which are largely specialties, has mainly utilized the second plan. However, they have also attempted to create consumer demand for specialty goods at a sufficiently large number of seasons to provide for almost constant operation in these lines. The sales department can often do much to eliminate seemingly unavoidable seasonal variations by forcefully attacking trade customs of purchasing, only at certain times, customs which are frequently built only on prejudice. Furthermore, through intensive sales effort, it can make plans, such as have just been mentioned, successful. The success of such plans lies squarely in the hands of the sales force, for unless they attempt to push supplementary lines or staple lines that have been developed, the only result will be the disastrous one of tying up capital in unmoved and increasing inventories.

Sales promotion. Effective sales control can be secured only if there be carried on definite sales-promotion work, which will point the demands of the market in the direction which is desired. This promotion work in large companies can, in its routine aspects, be handled in the main by a sales-promotion department, operating only under the general direction of whosoever may be in major charge of distribution. However, the latter will be forced to lay out the major lines of operation for the sales-promotion department, if he is to correlate their work closely with that of his own direct assistants, and with the administrative program which has been laid down for the company as a whole. The sales-promotion department must be in constant touch with the salesmen or distributing agencies which are actually selling the product, and must be in a position to aid them to push a certain article in the manner which may seem most effective at any particular time. The control of advertising campaigns and appropriations can be placed under such a department, though the actual preparation of advertisements and direct contacts with publications or printers is often left in the hands of an advertising department, or with an advertising agency.

A sales-promotion department knows the customers and knows the trade thoroughly. In addition to this, it knows the products which are being manufactured exceptionally thoroughly. Through the head of sales, it knows the programs which have been laid down for a forthcoming

period, and with all these factors in mind it constantly strives to promote the realization of the developed sales program. It gives the salesmen the home-office aid that is necessary, when and where it is necessary, and in doing this it co-operates directly with the sales manager or whoever may be in direct charge of the salesmen. It maintains a stock of the various "dealers' helps" which have been devised, and distributes them to dealers. This also will be handled in a way which will promote any particular campaign or program that has been determined upon.

Sales policies, such as guarantees, dealer-service, price-protection, and discounts, must all be developed so as to fit in with the promotion program and with the general administration program of the business. It will not avail to carry on whirlwind sales methods within the first portion of a business period in the effort to achieve some assigned quota, if this is but to result in reaction toward the end of the period that will entirely disrupt the plans of the executives. Policies of dealing with the dealers and with the public must be developed from the standpoint not only of one campaign or budget period, but of long-run results. Such policies make it possible to bring to a satisfactory conclusion the plans of any particular period, and they also make possible the setting of plans for future periods with the assurance that they can and will be carried out. If sales policies and sales promotion are carried on in this way, costly revision, which affects not only the sales force but all portions of the business, may more frequently be avoided.

Sales planning. The step which makes entirely practical the pre-determination of sales effort and the resulting control is sales planning. If sales plans have been perfected, to carry them out will be but to call upon the technique of sales as developed in the sales organization through the ordinary channels of salesman-dealer or salesman-consumer relationship. Sales planning must be extensively developed before a sales program, which will hold, can be developed. Yet some of the most effective planning must be done after the formulation of the program and in an attempt to carry it out. There will be no attempt here to differentiate between these two types of sales planning, since no practical distinction can be made. In laying plans to carry out one program, lessons are learned which are of material aid in formulating the next one. Sales planning involves these steps: (1) product analysis; (2) territory analysis and construction; (3) building, analyzing, and rebuilding the sales personnel; (4) setting quotas for each branch, agency, or salesman; (5) routing of salesmen; (6) scheduling of salesmen; (7) analysis of sales results. Planning for sales which involves these steps is predicated on the thought that the sales manager must act strictly on facts, must carefully determine these facts, and must supervise his force in a way that will bring measured results from these facts.

The first step in sales planning is a careful analysis of the products to be marketed. This includes the determination of the section of the market to which the product will appeal, the status as regards competition, both extent and kind, best methods of marketing, prices, discounts, etc. It will be seen that many of these points are ones in which the general management of the company must give advice or must perhaps make the final decision. Many others are ones in which the financial and administrative ends of the business must be consulted, as in price and discounts, while others are purely for sales-department determination, as the section of the market to be attacked and the methods of marketing. On a careful analysis of each article of product is built the other steps in sales planning. If articles are manufactured to customer's order, capacities and delivery dates must be kept constantly in mind.

Territory analysis and construction involves, first of all, a decision concerning that portion of the market which is to be entered, and also the portion which is to be entered intensively and the portion to be entered extensively. Decision on such points must necessarily be made not only on the basis of the appeal which the article makes but in terms of the plant facilities and the cost of selling. If the articles produced are not extensively used, the territory must usually be a wide one. If the articles are of general use, it may be that other conditions will make it advisable to concentrate on a small portion of the country, or a few states, rather than spread effort thinly over larger territory. Cost of sales will increase as territory is enlarged, rather than as it is intensively worked. But cost of sales will also increase as a given territory is intensively worked beyond a certain most profitable point. Decisions on territory to be worked will vary continually as between products and with given products, but it is necessary to be careful that nearby profitable sales are not passed by to secure alluring but expensive sales at a distance. After deciding what territory to enter, it is necessary to determine the way in which it is to be split. Although districts or territories should in the main be created according to their purchasing power, nevertheless transportation conditions, dependence on given distribution centers, the personnel available, and the degree of intensive working that has been determined upon, all enter into the exact construction of sales zones.

In building up a sales organization many sales managers have desired to hire their own salesmen, largely with the thought that no one except a salesman can select another salesman. If the personnel department be of major caliber, there is no more logic in this reasoning than in the feeling that foremen must hire their own machine workers. A high-grade interviewer should be able to make preliminary selection of salesmen and factory workers with equal facility. Of course, if the personnel department be purely a factory organization, selection of salesmen must be left to the

sales organization. Salesmen must be selected for particular territories with a view to the buyer resistance within that territory. Polished salesmen might succeed in one place where rough-and-ready salesmen would succeed in others. Although a really successful salesman seems to adapt himself to whatever conditions he meets, buyer resistance is cut down by properly apportioning territories among the sales force. The enthusiasm of salesmen in attaining sales goals can be stimulated by methods of payment, as indicated in Chapter XXVIII. If salary and commission payment is adopted, the two methods must be balanced so as to be most effective. However, this must be so arranged that the entire urge will not be in the direction of increasing the amount of sales, with possible injury to net profits from sales or to customers' service. Commissions should also be based partially on the success of the salesman in reaching quotas which have been established for him. That is, compensation must be based on production, and production in turn must be determined in relation to a set task and quota. This task or quota may vary with the product, with the territory, or with the salesman involved.

Setting sales quotas. To fix quotas, it is essential that territories shall have been first clearly defined, in order that they may be studied, and the fair share of projected sales apportioned. Not only for this reason, but in order to make equable the opportunities and compensation of the salesmen, territories must be clearly defined and studied. The quota itself, like any other task, should be fixed in such a manner as to be readily attainable. There is no object in setting quotas at a point which is known to be utterly out of reach. Thus the quota should be set on study, not on previous sales, or any arbitrary increase over previous sales. Such a practice as an arbitrary increase merely penalizes the salesman who has always done well consistently, and throws out of kilter the plans for total sales that are being laid. Although quotas must be fairly well worked out before the sales estimates are submitted for budget-making purposes, nevertheless they will have to be revised after the adoption of the budget to insure that its schedules are attained.

Quotas must be set with certain factors within the territory in mind. The first is the accessible population. Inaccessible population cannot be counted. Some knowledge of trade customs within the territory is involved here. On goods which are sold for household purposes such factors as the strength of mail-order houses must be taken into account, and the character of transportation facilities must be considered. On products which are used largely in trades or in manufacture, the usual channels of purchase must be thoroughly studied. The only population which is of value is that which may properly be expected to be in the market for the product. Thus, if quotas are being set on shirts retailing at \$3.50, the available population is reduced considerably under that

which must be considered in setting quotas on shirts which sell for \$1.50. Crude population statistics are, therefore, of little value in setting quotas, although they may be utilized as a point from which to start. The number of outlets must be determined. This may be the number of dealers, or in some cases the number of direct users of a product. Thus the quota of a branch sales office of an automobile accessory manufacturer located in Detroit would necessarily be higher than the quota of the Cleveland branch. The volume of prior sales must be given some consideration, as must the extent of competition within the particular territory. This last factor may run up cost of sales to the point where it may be desirable to abandon certain territories. The relative advertising expenditures compared with competitors must be taken into account. Market conditions within a territory should affect the quota set for it. Thus, crop failures in a farming community must affect the quota set for that community the next year for nearly all products. New sales efforts may affect all quotas, or they may affect some to a greater extent than others. If intensive advertising campaigns are to be run in certain sections, the quotas for those sections must be advanced correspondingly, as the salesman and dealer aid from this source will be considerable.

After territories have been outlined and quotas set, real control of sales demands the routing of the salesman through this territory. To allow him haphazardly to visit certain towns and skip others may mean that he is taking the path of least resistance, rather than the one of most profit. The territory should be carefully analyzed, and a route list prepared for him indicating what towns he is to visit, and perhaps, whom he is to see in those towns. Much valuable information can be secured from the salesman himself in this connection, but he should be called upon to present adequate reasons why certain towns or possible customers should be omitted from the list. Salesmen easily fall into the habit of neglecting outlets which they do not happen to like. There must, therefore, be provided some means of checking calls against route lists which have been provided for them. Many firms provide an exact schedule for their salesmen, detailing exactly what calls shall be made by them on specific days, and asking for an adequate explanation of failure to make expected calls.

Analysis of sales. Sales planning must be followed by a careful analysis of results achieved, if plans are to be modified and corrected as necessary. Territories which have proved to be unprofitable must be given up. Territories which cannot be adequately covered by one man or which might be better handled by another branch, must be changed to fit ascertained conditions. Careful study of campaigns which have been previously planned will give satisfactory information for these changes that affect subsequent campaigns. As plans become more effective, high-priced salesmen should be utilized more and more on high-priced work,

and satisfactorily directed from a home office through the utilization of low-priced clerks to aid the sales manager.

The director of distribution and the sales manager, if these be different persons, are enabled, after they have established the control which has been outlined, to co-operate more intelligently with the production executives, truly to determine their best salesmen and best branches, and to reward them accordingly. Furthermore, the sales manager is enabled to travel into difficult or highly competitive territory and to lend a helping hand to his salesmen there. He can be confident that the remainder of the men will be working toward a definite goal while he is thus helping a single individual, and he will gain much-needed knowledge of actual competitive conditions by being free to swing from under the routine of office work and work with his salesmen. Special awards, bonuses, and contests for salesmen come to have real significance if sales have been previously planned. The sales manager will find that, through these aids, he will have the concerted effort of the whole sales force bent towards the fulfillment of the sales promises which have been made to the general management and the other operating departments. Without planning and subsequent analysis, he will be playing a lone hand, endeavoring to make good on his promises, and through main strength, endeavoring to bring the members of the sales department to his assistance.

CHAPTER XXXVIII

CONTROL OF INVENTORIES

Importance of inventory control. The business survival of an industrial enterprise may readily rest upon the effectiveness with which it controls its inventories. This is particularly the case if the purchasing function be considered a portion of inventory control. The stores and partly finished stock on hand often represent from a quarter to a half of the capitalized value of the business. Wastage, obsolescence, or poor purchasing may quickly wreck a concern through inventory losses. Poor control of materials is frequently accompanied by poor storeroom administration in a way that may easily throw out of balance any operation programs which have been adopted. It seems almost incomprehensible, but it is true, that plants which have maintained accurate records of petty cash accounts totaling \$100 have failed even to attempt to control accurately material accounts involving thousands of dollars. Such concerns operate their storerooms in such a manner that the only check on materials comes with the "taking of stock," or inventorying, once each year.

If the business be budgeted, or if only sales and production programs be adopted, it is essential that an inventory control be set up which will provide material as it is needed, and will not at the same time tie up large sums of capital which might be used in furthering the operating program in other ways. No system of budgeting can be successful unless effective inventory control has preceded it. Otherwise production obligations cannot be met by the manufacturing department, at least within the allowed cost. Or perhaps the financial program will be overturned through undue demands from the purchasing agent or interest charges on capital invested in material. The daily routine of cost accounting, with or without an administrative budget, demands that material be controlled accurately and intelligently.

Sources of loss from improper control of inventories. The sources of loss from improper control of inventories include the costs of excess purchases, the costs of slowing up production by not having material available when wanted, and losses through improper diversion of material, either wastefully or willfully. The losses due to excess purchases provide a continual pull toward small stocks, and the losses due to production tie-ups provide a continual pull toward large stocks. It is between these that a

balance must be struck. The losses due to improper diversion of material necessitate the maintenance of adequate material records.

Excess purchases will bring with them not only the losses in interest and ability otherwise to utilize tied-up capital, but will bring with them direct loss from depreciation on the material and frequent loss from obsolescence, which may be so large that high-priced goods may have to be sold for the price of waste or junk. Good inventory control will prevent the purchase of materials except as they are needed, and will prevent the ordering of goods when large quantities are on hand already, or the ordering in quantities which are excessive. Particularly in standard products, graphic charts provide a means of eliminating expensive over-purchases. Over-ordering is costly on a stationary material market, while in a falling market it conceivably may lead to bankruptcy. Damage and deterioration due to overstocking must be reckoned with. Excess quantities frequently encourage poor storing, with consequent damage to materials. Furthermore, many articles, such as foodstuffs, drugs, and rubber, deteriorate with age, which may mean a total loss of all materials purchased above immediate requirements. One company manufacturing chemical products found, in instituting real inventory control during a depression of 1920, that they had sufficient of a certain ingredient to last forty years at the rate of use over the preceding few years. The losses incident to such a condition cannot occur with adequate inventory control.

To prevent slowing down production, large stocks of materials have often been purchased haphazardly, thus bringing about the foregoing conditions. And yet if materials are not on hand when needed, manufacturing costs are run up to the sky and manufacturing programs are shattered. To promote smooth factory operation and to prevent the piling up of idle machine time, proper material must be on hand when it is wanted. If material is not available in continuous process industries it may result in the temporary shutdown of a large portion of the plant. In any plant where operations, machines, and orders have been finely balanced, this will mean untold confusion. The storeroom is a service department, and quick, prompt delivery of materials to manufacturing floor or of finished goods or repair parts to customers is all-important.

With the growth of hand-to-mouth buying by jobbers and retailers, it has become of increasing importance to have adequate inventory control. Service has come to be of increasing importance in securing sales and holding business, and prompt service demands that stocks contain wanted articles. This is assured if the inventory control be scientific.

Improper diversion of materials through excess use is a commonplace in many plants. It has been eliminated in as many others. Frequently material is thrown away, lost or damaged while in process, without any record providing a check. One textile concern has stated that they only

secured in finished goods two-thirds of the material which they put into process, and while they thought they knew what happened to the rest, they had never investigated to ascertain the real conditions. When a workman sees that the management does not keep a close check on material, he does not hesitate to waste it or to dispose of excess in the easiest way. One cause of this condition is found if the plant allows excess material to remain in the production departments and be used on future orders, rather than to be returned to the storeroom. This is a common practice in fabricating plants where cartons of raw material, the product of other plants, are used extensively. In such shops, issuances are not checked in the storeroom or elsewhere against production orders, and thus standards of consumption are lacking. If the workman damages material, he can usually receive additional material from the storeroom without much questioning.

Direct thievery, although often important, is usually the smallest source of loss from improper material control. In some plants workmen have uncontrolled access to the storeroom. To allow this sometimes results in startling losses, especially if the material is of a type that is easily disposed of to pawnshops or to junk dealers or can be used in radios. To protect materials from thievery is an obvious need of any stores system. Nevertheless, one plant allowed the storeroom to form the exit through which a number of the workers left the plant at night, their time clocks being located in the individual departments. The storeroom man made a practice of "beating the whistle," and the unattended storeroom was an invitation to theft which was accepted. The stock of small brass parts was always low until this condition was corrected.

Good inventory control which, together with good storeroom and purchasing department operating methods, can eliminate these losses, implies the following steps: (1) the fixing of minimum quantities, or ordering points, and of maximum quantities, or amounts to order, on all articles; (2) arranging a method for allocation of material to orders in process or contemplated; (3) creation of stores accounts, which will control the storeroom and not be controlled by it.

Setting a maximum and minimum on materials. To set a maximum and minimum will be advisable, regardless of the number of articles of stores or worked materials to be controlled. If a minimum and ordering quantity be set, the addition of these two will equal a maximum, and the same purpose will have been achieved. Hence the term "maximum and minimum" will include the setting of an ordering quantity. If there are large numbers of articles it will be well to divide them into broad classes, the individual articles in which all will have maximum and minimum quantities controlled by the same factors. The factors which determine the maximum and minimum point for each article of stores may be divided into two broad

groups. First is a group of general factors applying to all articles carried, such as general business conditions and the prospects of the particular business. Second is a group of factors directly dependent on the article itself. These are somewhat intertwined with the first group, but may cause special treatment for some particular material. There has never been developed a satisfactory formula for fixing the maximum and minimum which will hold good for all plants, although individual plants have been able to develop formulae which fit their own conditions.

Predicted consumption during a given period, as indicated by general market conditions, by the state of health of the concern, and by the announced firm policy toward lines being manufactured, forms a basic consideration which is reflected in all other factors. In periods of increasing production and great market demand, ordering quantities may be raised, and the minimum frequently must be raised. This is not only because of the more rapid consumption of the articles, but because general business conditions have brought with them market and transportation situations which prohibit rapid replenishment of material stores. If business conditions are the reverse, the minimum must be lowered generally. A major factor to be considered at the same time is the probable trend of prices in the commodities to be purchased. This may or may not follow general market conditions. Two more general factors peculiar to the business are the condition of finances and available capital in the business itself, and the extent of storage facilities which are available. In considering this latter factor, the cost of new storage facilities, or interest thereon, must be balanced against the cost of carrying inventories which the present storage facilities can handle. Changes in the line of product, particularly standardization programs in process of development, may easily be the most important of these factors which are general to all materials carried.

There are a number of factors which are peculiar to each article and which must therefore be considered separately for each: (1) The consumption of that article over a past period must be considered in connection with the general factors just mentioned. (2) There is a profitable manufacturing or ordering quantity. The latter, particularly on special goods, implies the profitable manufacturing quantity in the vendors' plants. These can best be determined by experience and quotations. Ordering quantities must always be set with due regard to commercial usages. It is valueless to set an ordering quantity which is mathematically correct, but which does not represent a quantity which can readily be ordered on the market, or profitably manufactured within the plant itself. In determining the importance of this last factor, the desirability of keeping certain men or departments busy at a given time must necessarily exert an influence. Thus some concerns, with capital available, have actually raised each minimum in times of poor business, in order to keep their working force

employed. (3) The probable depreciation or obsolescence will influence the amount that should be carried in stock; (4) On small, inexpensive items, the clerical cost of ordering, receiving, and payment of bills may cause the ordering quantity to be raised. (5) The last factor is the time necessary to secure the article after requisitioning. On purchased goods for which there is a regular source of supply, this will include the delivery promises of the vendor and the time taken to transport the article to the user's plant. On worked materials, it will be dependent on the time taken to work up a manufacturing order for the ordering quantity within the plant itself.

The first step in inventory control has been taken when the maximum and minimum have been set on all articles. On standard products, made to a manufacturing schedule, these may often be set in a much simpler way by setting production requirements for a given time as the minimum, and production requirements for another stipulated time as the ordering quantity.

The balance of stores sheet. The other steps in inventory control are taken through the use of a balance of stores sheet, such as that in Fig. 111. Such a control sheet actually controls the storeroom, and is not merely a record of material on hand. Many forms of balance of stores sheets have been devised to meet individual operating conditions, but all that give the necessary control are uniform in providing four important balance columns, which actually, together with the maximum and minimum which have been set, control the inventories. These balance columns (Fig. 111) are headed "Ordered," "Balance on Hand," "Apportioned," and "Available." Apportioned is frequently called "Applied on Orders." In either case it governs that material which has been allocated to given manufacturing orders, but not yet withdrawn from the storeroom.

The Apportioned column insures that material will be on hand when wanted for manufacture, and successfully eliminates the practice of relying on the same lot of material to fill two orders. Unless materials are applied as delivery dates are stated and schedules for manufacture are prepared, it becomes likely that the planning department will rely twice upon the same materials. The Available column indicates the amount of material which is still available for assigning to orders. The last balance in this column is continuously compared with the stated minimum to determine when to order, rather than the balance in the On Hand column. Unless this were the case, goods might be on hand well above the minimum, but might be ordered into production to-morrow for orders already in the plant, to such an extent that the danger point might be reached and passed long before a new supply of goods could be secured. This balance sheet provides a continuous check as to its accuracy, inasmuch as Column 1 (Balance Ordered) plus Column 3 (Balance on Hand)

should always equal Column 5 (Balance Apportioned) plus Column 6 (Balance Available) after any transaction has been entered.

To indicate clearly the operation of this sheet, which is basic in inventory control, the accompanying illustration will be explained. The article, 2-inch hollow steel tubing, quality, specification "B," has had its minimum set at 800 feet, and the ordering quantity at 4000 feet. The maximum is therefore 4800 feet. On June 14 when this sheet was opened, there was on hand a balance of 1500 feet, which was also available to be apportioned. The unit value of this material, as brought forward to this sheet, was 35 cents per foot. The first transaction was an issue to the shop of 600 feet, without previous apportionment. The next transaction was a similar issue of 300 feet, which brought the Balance Available below the minimum, and hence caused the entering of an order for 4000, the ordering quantity. Upon ordering, this amount is considered immediately available for apportionment, although it is not yet in the plant, and hence not ready for issue. (On commodities or in times when prompt delivery cannot be expected, it is unwise to consider material which has been ordered as available until it has been shipped.) On July 20, production order No. 3982 was entered, calling for 1200 feet of this article, which was immediately apportioned to this order, and taken from the Available column, although the order was not yet to be placed in production. On July 28, 300 feet of this amount was issued to the shop for production, and therefore deducted both from the Balance on Hand and the Balance Apportioned. Next, on July 30, the material on order arrived, and was deducted from the Balance on Order, and added to the Balance on Hand. The new material cost 40 cents per foot, and there was so little of the old supply on hand that the unit value was increased to 40 cents also. The next transaction called for the issue of 600 more feet of the material apportioned to production order No. 3982, which was deducted from the Balance on Hand and the Balance Apportioned. On August 20, production order No. 4071 was received, making necessary the apportionment of 1800 feet, making the Balance Apportioned 2100 feet, and the Balance Available for apportionment 1600 feet. On August 22 the remaining 300 feet apportioned to order No. 3982 were issued to production, again reducing the Balance on Hand and the Balance Apportioned. On August 27 an unexpected order (No. 4124) was received, calling for immediate production of articles requiring 1200 feet of tubing. This order was immediately placed in production, the full requirements being issued to the shop on the same day that the order was received. This again brought the Balance Available below the minimum, and an order was placed the next day for 4000 feet (despite the fact that there still remained 2200 in the storeroom, 1800 feet of which, however, was apportioned to order No. 4071). On September 11, 600 feet were issued to the

tions this aids in keeping lot costs separate. Value columns may or may not be inserted, but are usually found. Values may be kept by the average or lot basis, as is desired, but in either case lot costs are easily ascertained from the record.

The balance of stores sheets may be operated by any division of the business which the organization may feel is best from its standpoint. They may be kept in the general accounting office, in the storeroom, or in some portion of the production office, preferably the planning department. It is usually best to separate control of stores from the stores-keeping function. Since the operation of the balance of stores sheets is primarily a function involving thinking ahead, and since it is so closely bound up with control of production, the most logical place to operate it is from a planning department if there be one.

Position of inventory control in the business. No method for the control of stores is a substitute for business judgment. In fact, judgment must be carefully exercised in carrying on the control methods just described. No methods as yet devised will automatically increase a minimum on a rising market or decrease it on a falling market. They provide a useful tool for the management and are a means to an end. Together with the balance of stores sheet, they form a very satisfactory basis for good inventory control. They must be supplemented by other management steps. These include the establishment of a proper physical basis for the inventory control that has been set up; a proper storeroom paperwork system, and intelligent purchasing, carried on by a purchasing agent who is able and willing to co-operate with the other branches of the business interested in inventories.

CHAPTER XXXIX

STOREROOM OPERATION

Types of Goods Stored. Storerooms of manufacturing establishments must deal with three main types of goods: (1) Raw materials, properly termed "stores." These include supplies, or goods only used indirectly in production. (2) Partly finished materials, or stores on which some work has been performed. These are usually termed "worked materials," and may include finished components awaiting assembly or shipment to customers as replacements. (3) Finished product awaiting shipment, properly termed "stock." Storeroom arrangement and operation must take into account the varying problems presented by these separate classes of goods.

Location of the Storeroom. In considering plant layout it was shown that the storeroom should be centrally located with respect to the production floors on which the material is used. This idea of a central location has been over-emphasized in some plants. They have felt that centralization means that there can be but one storeroom, and they have defeated the very purpose at which they have aimed, namely, decreasing the expense incident to handling and rehandling material. The storeroom may consist of one room, one building, or a main storeroom with subsidiary storerooms advantageously located for the storage of special materials or materials for particular departments. The nature of the industry, the site occupied, the situation and size of the buildings, and the arrangement of departments within the building must determine storeroom location. For instance, with bulk materials, ease of receiving through the use of gravity may place the storeroom far from the point of use of the material, which may be reached through the use of overhead cranes or conveyors at a smaller cost for small lots of materials than for the large lots in which the materials are received. To place such material near the point of usage would only mean two handlings of the material by the conveyors or cranes instead of one, and would increase rather than reduce the handling charges. The growth of material-handling equipment has made storeroom location more flexible, as such equipment can be used to transport materials either to subsidiary storerooms or from a central storeroom to operating departments.

The location of the storage space will depend on the nature and value

of the materials to be stored and the rapidity with which amounts will be received and issued, as well as upon the point at which they will be placed in manufacture. Bulky materials, such as sand or pig-iron, demand different treatment from that given to material which must be loaded by hand. Material such as paper pulp is too bulky and used too rapidly to be stowed into bins. However, the storage problems relating to such materials can well be studied. For instance, paper pulp, instead of being stored in huge piles, involving rehandling when needed, can be placed on platforms to be picked up by transfer trucks, each platform containing a standard quantity properly tagged to indicate lot numbers and specifications.

Heavy materials generally must be stored on the ground floor, whereas material that is light can be easily handled and can be fitted into almost any location that is otherwise desirable. Materials that are easily broken require facilities for protection and this protection must take precedence in the fixing of the storage place. Similarly, valuable material necessitates not only consideration of location but of safety. Some articles can be stored only under particular temperature conditions, and the storage place must be fixed with temperature regulation in mind. For instance, rubber must be stored in a place that is neither too dry, too damp, too cold, nor too hot. Inflammable material often demands a separate storage space that will not only protect the material itself, but will also reduce the fire hazard for the remainder of the establishment. This may mean that a separate building will have to be erected, or a sort of fire-proof vault provided within the storeroom, possibly communicating with the remainder of the storeroom through double fire-doors.

Any plan for the location of a storeroom must be flexible enough to allow for growth and other changed conditions which arise over a period of years. If such conditions cannot be foreseen, or if the material stored will only be used for a short period, it may be profitable to consider the construction of temporary storage conditions that can be changed readily. Temporary platforms in a factory yard, with tarpaulin covers, have solved more than one such temporary storage problem. Relative cost must be the paramount consideration.

Storeroom layout. Having determined upon the general location of the storeroom with respect to the other departments of the establishment, the next step is to work out the layout and arrangement of the storeroom itself. The area to be provided for storage purposes will have been worked out during the study of the location of the storeroom. Too much space will add to the indirect cost of storing the material. On the other hand, insufficient area will increase costs because of the congestion that will result. Lack of space granted the storeroom will often lead to a reduction of the quantities that may be carried, so that production is

seriously hampered. The amount of storage space to provide is easily determined where a standard product is being manufactured, but not where numerous products of varying kinds are being produced.

The physical arrangement and layout of the storeroom involves allotting space for more than the actual storage of the goods. For smooth storeroom operation it is necessary that a section adjoining the entrance to the storeroom be reserved for the receipt of material as well as for its inspection prior to storage. Also, space must be provided for material withdrawn for issue to the production floors, but not yet removed from the storeroom. This will enable the man in charge of the storeroom to work up his issuances in advance, in order that there may be no delay when the goods are actually required. The confusion avoided in handling receipts and issuances will more than justify such an assignment of space.

As in the layout of production floors, one of the most essential features of storeroom layout is to provide adequate aisles and passageways. These will permit materials to be brought in and taken out in the most expeditious manner. Aisle space should be reserved for use as aisles only, since nowhere more than in the storeroom does material stored in aisles cause delay in handling goods. In the case of bulk storage, the storage areas and aisle spaces may be marked on the floor with paint. The layout of aisles will vary according to the needs of each storeroom, but in general it may be said that main aisles should allow the passage of two trucks and should vary from 6 to 8 or more feet in width, while other aisles will usually only have to allow for one truck. In blind aisles running up to a wall, allowance may have to be made for the turning of the truck. Where the articles stored are of such a nature that they are generally carried by storemen, the width of the aisles between the rack has been standardized at 30 inches in some storerooms. Wherever possible, aisles should be directly opposite windows for adequate light and ventilation, since there is no economy in narrow, dark aisles. Congestion and mistakes soon occur, and workmen move by hand what should be handled by trucks. Errors in stowing and removing goods are frequent. Figure 113 indicates the proper relationship of aisles to storeroom layout. The desirability of a central location for receiving and issuing, as well as assembling stores for stowing or issuing, is also shown.

Arrangement of material in the storeroom. The arrangement of the material within the storeroom will depend largely on the articles to be handled, the use to which they are put, and the classification which has been developed. One of the chief advantages of a well-developed classification is the aid that it gives in storeroom operation. Before the storeroom can be arranged, it is first essential that there be established a systematic arrangement and designation of the material to be handled. These, we have seen, are best secured through classification and standard

nomenclature. Regardless of whether the storeroom is arranged by classification or not, this will prove to be of value in arrangement. There are two main ways of arranging a storeroom: (1) directly by classification; (2) by index. Both are widely used.

If material is arranged by classification, it should be stored in the classification order. If the mnemonic system is being used, the first racks should include all those articles whose symbols begin with F, or whatever is the first letter, and the last racks should have stored on them those articles whose symbols begin with W, or whatever the last letter may be. All intermediate racks should be alphabetically arranged, and a system should be developed for the alphabetical arrangement of each of the racks themselves, so that an article of stores may be found in the rack much as a word may be found on the page of a dictionary. Bulky goods which

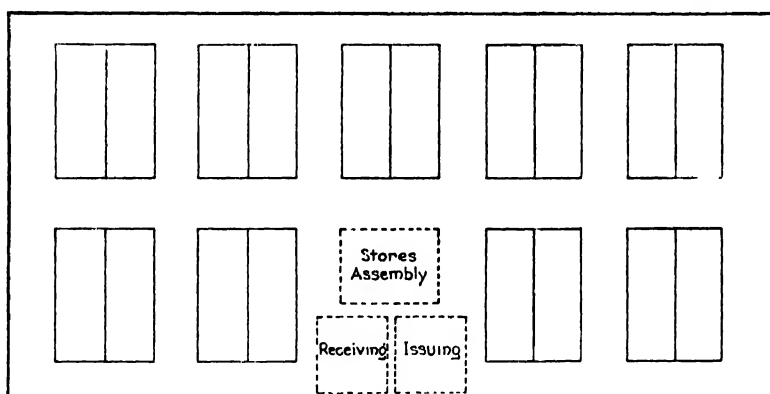


FIG. 113.—An Effective Storeroom Layout. Windows will be in exterior walls opposite aisles.

cannot be stored by symbol are put in a convenient place, and a tag is hung at the point where the symbol would appear on the racks, giving the location of the material.

This arrangement of materials may be best illustrated by indicating the way in which it might be worked out in a particular plant. At the end of each rack on a central aisle, keyboards are placed which indicate the range of the contents of the rack. For instance, one of these keyboards might read SVZM-SVZY. This would immediately indicate that all articles of stores whose symbols were alphabetically between these two could be found in this rack, and this fact would be used in much the same way that the tabs on the side of a dictionary are used in finding the approximate location of a word. Each rack is divided into divisions, and these into sections and subsections, as is indicated in Fig. 114, which is an illustration of a main division. In stowing and locating material, each

division is read separately, beginning with the upper left-hand corner (Section A), then across to Section B, down to Section C, and so on until Section H is reached. The subsections in each section are read in the same manner, the top row being read clear across before the next row

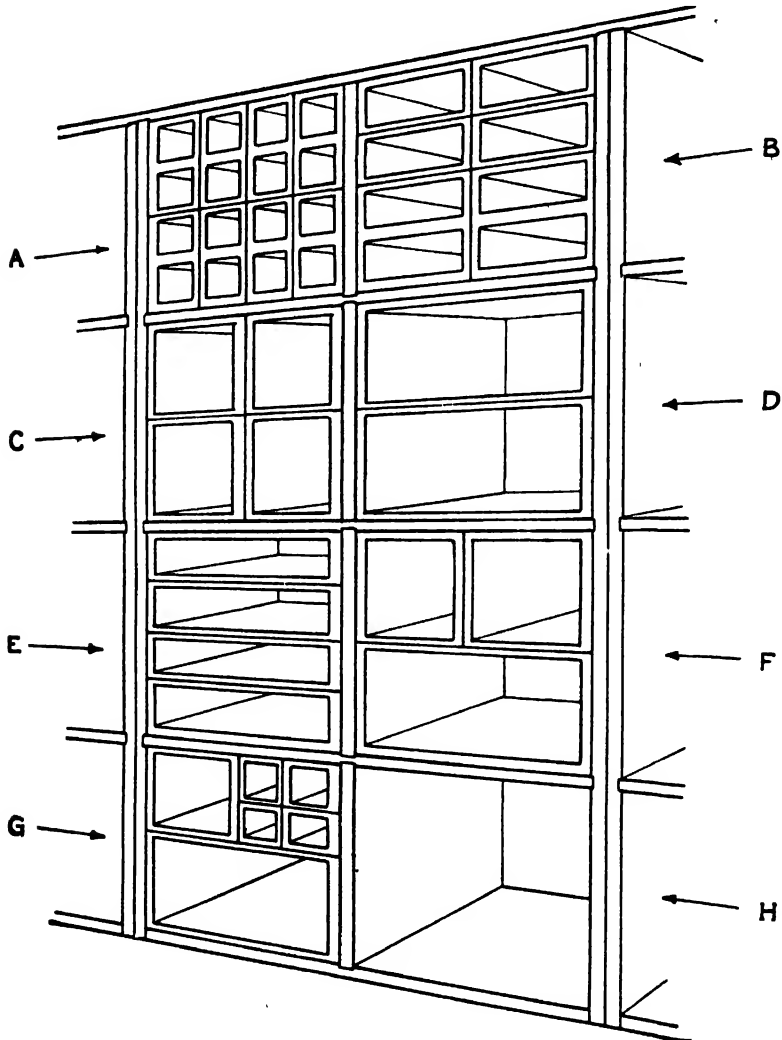


FIG. 114.—Storeroom Bin Arrangement. Flexibility gained by the use of wooden bins.

below. Thus, in arranging stores by classification, the symbol of the article in the upper left-hand subsection of Section B would immediately follow the symbol of the article in the lower right-hand subsection of

Section A. This whole arrangement makes easy the finding of an article without walking up and down in front of the rack.

Consider an issue for 50 of an article symbolized as $SV\frac{3}{8} \times 1\frac{1}{4}Z2M$. Since the keyboards on the ends of the racks show the range of the articles stored in the racks by letters only, the figures may be disregarded for the time being, and SVZM will be looked for. This we shall quickly find to be in the rack above mentioned, namely, SVZM-SVZY. We then proceed to look through this rack for SVZ2M, which we would immediately see was in a division near the beginning of the rack because the symbol is a subdivision of the first symbol on the keyboard of the rack. Having found this division of the rack, it is but the matter of a moment to locate the particular section and size of screws desired in this instance, namely, $\frac{3}{8} \times 1\frac{1}{4}$.

It is almost impossible for one unfamiliar with this arrangement to realize the ease and speed with which material can be located under this system. It is particularly valuable with small parts and for the storage of forms and office supplies. Storekeepers whose materials are thus arranged delight in taking the visitor to the storeroom, explaining the system to him, giving him a symbol to find, and watching him pick out the section of the rack in which the material is stored within a few seconds. A storeroom having its material so arranged is not dependent on one man recalling where he has placed certain material. The plant would not be greatly handicapped even if the whole storeroom force were to leave suddenly. However, arrangement by classification can be utilized only where there is no rapid change in goods handled. Under other conditions it is not advantageous, because it causes continual rearrangement of the storeroom. Under any circumstances it has certain very definite disadvantages: (1) A large amount of space (20 to 25 per cent) must be left in each portion of the rack to allow for expansion. (2) The goods most frequently issued cannot be placed near the issue window without breaking down the scheme of arrangement. (3) Certain goods, such as unwieldy materials or very heavy articles, can under no circumstances be stored exactly by symbol.

The second successful method of arranging a storeroom is by index. The materials in the storeroom are arranged in the manner most convenient for storage and issue, and then an index of material location is developed. In the index the material will be arranged by symbol, and the location in the storeroom noted next to the symbol. This method necessitates designating the racks, rows, and sections in some manner that will allow the bin location to be expressed in the form of a symbol also. One method of symbolizing bin locations is illustrated in Fig. 115. The racks are lettered, and the rows in the rack are numbered, beginning from the bottom. Finally, each row in the rack is marked off into numerical

divisions, which may or may not correspond with the bin arrangement. In designating bin locations, the row is used as the first digit, and the division number the last two. Thus, if the index indicated that an article could be found at D 408, this would indicate the article was in rack D, row 4, position 8. No attempt is usually made to number bins under this plan. It is particularly satisfactory if steel bins are used.

For the storage of large articles, which cannot be placed in bins, the storage floors may have each bay and section lettered or numbered, in such a way that the location of articles may be recorded in much the

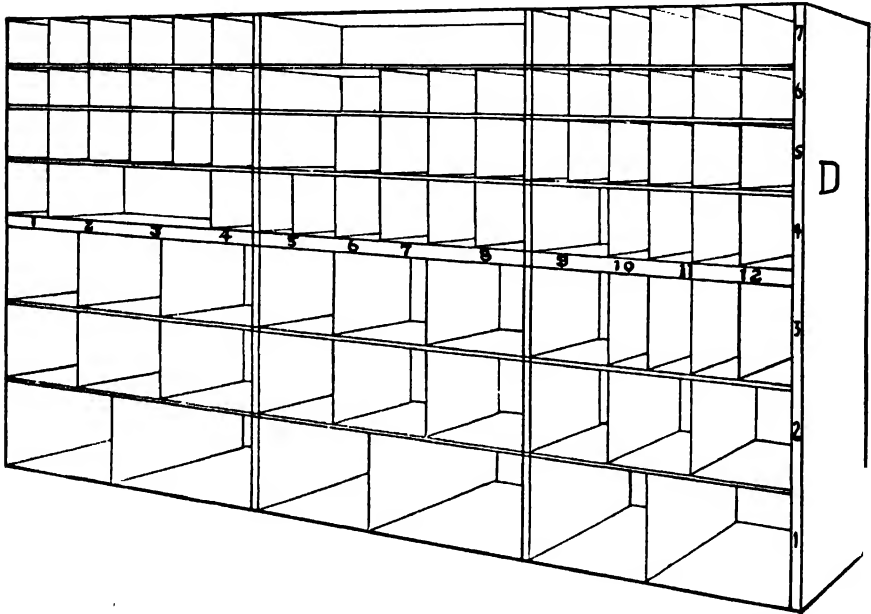


FIG. 115.—Storeroom Bin Arrangement. Steel bins arranged by index.

same fashion as if they were stored in bins. Such symbols are frequently painted on supporting columns or suspended from the ceiling.

The chief disadvantage of arranging a storeroom by index rather than by classification is that the index must be consulted before an article can be found. If the stores are well controlled this is not important, for the bin location can be inserted on the stores issue at the time that it is written. The advantages claimed for the arrangement by index are: (1) Stores can be so arranged that those which move fastest are nearest the points of receipt and issuance. (2) No rearrangement of the storeroom is necessary as new articles to be stored are brought in or storage of certain old articles is discontinued. (3) Goods can be stored with full regard for their special requirements for storage.

Types of bins. Wherever possible, and always where large numbers of small articles are handled, racks containing bins should be placed back to back, making material accessible from aisles running between the rows and thereby economizing storage space.

Obviously, the character of the stores will determine the size and method of subdivision of the bins, but some such plan as illustrated by Fig. 114 or Fig. 115 should be adopted. Figure 114 illustrates the use of standard wooden sections. These racks are made of 2-inch lumber, each division having eight sections, the inside dimensions of which are 2 feet in height, 2 feet in width, and 18 inches in depth. For purposes of flexibility some such unit should be devised, to fit the particular conditions encountered. In this illustration, each 2-foot division can be used as a whole for the storage of materials, or it may be subdivided by inserting units or smaller bins. Thus one compartment is filled with sixteen boxes or bins known as sixteenths. The construction of these boxes is such that their outside measurements are equal, making possible the placing of sixteen of them in a division. The sixteenths would, therefore, be approximately 6 inches square outside. Eighths, quarters, and halves are also used. The flexibility gained through this method of bin arrangement may be readily contrasted with the method of having all bins of equal size by reference to Fig. 116. The amount of waste space in this illustration is obviously expensive. Figure 117 is an illustration of a well-laid-out storeroom utilizing steel bins. Although such bins are of varying size, they are rarely changed, after being set up, except by inserting or removing dividing partitions. The rows are composed of standard steel shelving.

Both the wooden bins and the steel bins which have been illustrated make for very satisfactory storage arrangements. When standard lots of small materials are frequently issued, the idea of using tote-boxes as bin compartments should be considered. Steel shelving occupies less space than does wooden shelving, but it is more expensive. About 80 per cent of the space occupied by steel bins can usually actually be used for storage, whereas only about 50 per cent of the space occupied by the wooden bins described can be so used. The original cost of the steel bins per cubic foot of storage space will ordinarily be almost twice that of wooden bins. The better appearance and the sanitary and fireproof features of steel bins often cause their adoption.

Many materials cannot be stored in the type of bins illustrated, and special provision must be made for their storage. Such materials are bar stock and automobile drive shafts. Bar stock is ordinarily stored by placing it horizontally on the sides of racks shaped like an A, having hooks on the sides to hold the stock, or by leaning the stock vertically against such A racks. Automobile drive shafts are ordinarily suspended on

special racks to prevent bending. Many fragile articles, such as lamp shades, are suspended from the ceiling, thereby minimizing the jar to which they are subjected, particularly in buildings where heavy machinery is operating. Special storage also includes storing articles in the original package. Where there is a heavy turnover of small articles and the container is such that it fits in with the general storeroom scheme, this is sometimes very advisable. On the other hand, this practice must be carefully controlled, since it is usually cheaper to break original packages



FIG. 116.—Waste of Space through Inflexible Bin Arrangement.

when they are received than when the storeroom men are in a hurry to make issues.

Many storerooms use the double-bin system, providing two bins for each type of material. It is evident that the double-bin system generally requires more space, but those who use it feel that this additional space is not a serious enough factor to over-balance the advantages in its favor. The double-bin system provides an "in" and an "out" bin for each article. While the material in the "out" bin is being drawn for use in the factory, newly received goods are being placed in the "in" bin. When the "out" bin is empty, withdrawals are begun from the other bin which

is now tagged "out," and the empty bin becomes the receiving bin. The double-bin system prevents the accumulation of old material in the bottom of the bin, since it is used up before the new material is issued. This is of special benefit in the case of material which is likely to deteriorate. Another advantage of the system is that it gives a continuous physical check on the material to compare with the records, and this check can be made and is made each time that one of the bins becomes empty. This system is only successful when the kinds of materials carried in stock are more or less constant. When the amount of material of a given kind changes considerably, or the material is only carried intermit-



Courtesy David Lupton's Sons Co.

FIG. 117.—A Storeroom Utilizing Steel Bins.

tently, the single-bin system is generally better because of the saving of floor space. The single-bin system is far more extensively used.

Auxiliary storeroom equipment. Various types of material-handling equipment have been developed particularly for storeroom use. In their nature they are similar to the material-handling equipment for general use described in Chapter XI.

One of the perplexing storeroom problems where bins are used, and one that frequently prevents the use of the full height of the storeroom, is the problem of reaching the upper tiers of bins. The general practice is to use steps or ladders, but these are continually getting in the way, blocking

aisles, and, in the case of ladders, causing accidents, because the worker tends to lean too far to one side rather than move the ladder. One stores manager has developed the practice of arranging the bins in such a manner that the compartments at the bottom are large enough to receive heavy or bulky material, while those higher up decrease in size as they increase in height. For instance, at the top of the first row, the depth is reduced by one board, or a foot. This forms an offset that is usable as a platform in reaching the bins above the second tier. From this the workmen have easy access to material 5 to 6 feet above, thus making it possible to reach goods to a height of 8 to 9 feet without the use of a ladder or steps. However, ladders may be necessary under certain conditions, and where such is the case, those on trolleys have usually been found to be the most satisfactory. Some storekeepers object to the step arrangement of the bins because they feel it invites storeroom workers to lay articles on them "temporarily."

Storeroom personnel. To maintain any effective system of storeroom operation, the personnel of the storeroom must be well organized. It is essential that it should be in charge of some person who is directly responsible for the conduct of all its affairs. Fixed responsibility is especially necessary in the storeroom. Regulations must be put into force which prohibit all but storeroom employees from entering this department or which permit them to enter only in the presence of the storekeeper or one of his assistants. Only under such conditions will it be possible to make the storekeeper solely responsible for the preservation of and correct accounting for material. The size and character of the organization for the storeroom will vary with the size and the character of the business and the character of the material to be handled. Thus it may consist of one man known as the "storekeeper," who may give all or only part of his time to the work, or it may consist of a force of men giving full time.

The statement may be heard that such conditions are only applicable to large plants. On first thought it may appear to be poor practice for the small concern which can only keep a man partly busy on storeroom work to place one man in charge of the storeroom. Even for the small plant, however, it is advisable. For instance, it may be quite possible to assign an office employee to the storeroom for a certain length of time each day. By establishing certain hours in the morning and the afternoon this clerk can take care of all calls for material. At other hours he can attend to his regular work in the office. Some companies have met the situation by placing a workbench in the storeroom at which a worker is engaged while not devoting his time to storeroom work. A manufacturer of centrifugal machines, employing fifty men, has combined the functions of storekeeper and shipping clerk in one man. As a result, responsibility for

the storeroom is focused on one man and a full day's work is being obtained from him.

Maintenance of stores records. If balance of stores control be carried on elsewhere than in the storeroom, there should be a minimum of stores records maintained in the storeroom itself. The storekeeper can, nevertheless, be of great aid in carrying a share of the load of controlling inventories, if he studies conditions within the storeroom and the shops, ascertains needs, and co-operates with the purchasing department and the balance of stores clerk. In insuring smooth and prompt operation of storeroom routine will lie his greatest service toward good inventory control.

The storekeeper must provide a positive check that will insure that articles on hand will not fall below the designated minimum. This can be provided in some cases through the physical separation of the minimum by a partition, by placing it in a separate box, or by tying it together in a way which will call attention to the fact that some of it is being issued. Another check can be provided in the form of a bin tag on which records of receipts and issues can be maintained. If a separate bin tag be utilized for each lot received and issues deducted from the tags, sending bin tags which read zero to the balance of stores clerk may prove a valuable check. Figure 118 illustrates a very satisfactory form of bin tag. To be effective it must be simple, because of the usual character of storeroom labor. Many managers feel

AS 1			O
DATE RECEIVED			
Mon.	Day	19	P. O. 22791
6	21		
S V102F			
NAME OF ARTICLE			
1" Malleable Tees			
Date Issued	Quantity	ISSUED FOR	
	9		
7/14	2	M1317	
7/29	1	M1422	
CONTINUED ON BACK			

Fig. 118.—Bin Tag.

that a bin tag is unnecessary and that it serves no valuable purpose, particularly since it is difficult to keep it accurately.

Procedure for ordering material. The procedure for receiving goods into the factory storeroom will be described in detail. Goods are ordered by the purchasing department, either upon their own initiative or, in procedures such as we have described, on requisition of the balance of stores clerk. For special materials, unclassified, requisition will usually be made directly by a department head, although the approval by the balance of stores clerk may be made necessary to prevent duplication of items. After receiving the requisition, the purchasing agent makes the purchase, and then sends a copy of the purchase order to the balance of stores clerk, which is the basis for an entry in the "ordered" column of the balance of stores sheet. A copy of the purchase order may be sent to the storekeeper to serve as a basis for identifying and checking material when received. Some plants do not enter the amount ordered on the copy which goes to the storekeeper, in order that accurate count on incoming goods may be assured.

Receiving stores. All material received should be turned over to the receiving department, which may or may not be under the control of the storekeeper. If articles were delivered directly to the person for whom they were ordered, in many instances the receipt would not be recorded, which would lead to difficulty when the invoice was received. The date received, order number, weight, number of packages or bundles, charges whether prepaid or collect, and other necessary information should be recorded, so that a check can readily be made with the invoice.

As soon as a shipment is received the storekeeper should refer to his copy of the purchase order. He should be responsible for the count and ordering of inspection of all materials received. Theoretically, this should take place before the goods are accepted and receipted for. However, to facilitate receipts by team or truck, delivery receipts are often signed as follows: "Received subject to count, weight, and inspection. Signed——." In this event the contents are carefully checked and inspected at a convenient time. As soon as the material has been physically checked by the receiving department, a comparison should be made with the copy of the purchase order. Word should be sent to the purchasing department, stating the quantity of material and the general condition in which it was received. Such a report is usually termed a "Notice of Arrival," one copy of which goes to the inspection department as a notice that inspection is needed. In large plants, representatives of the inspection department are part of the receiving-room staff.

Upon inspection, the inspector should fill out an inspection report, stating that all material is satisfactory or indicating rejections, with

causes. One copy of this report should go to the accounting and one to the purchasing department to serve as a guide for the checking and payment of the invoice from the vendor, and for the making of claims. Where it is obvious that the material has been damaged or partly lost in transit, notice should be sent to the agent of the carrier to inspect the material. This will facilitate matters where a claim is to be formally made. Receipts of material in excess of the amounts called for on the purchase order should be tagged as "over shipment," with proper identifications, and placed to one side awaiting final disposition. A rejection tag should be placed on damaged or incorrect shipments. It is essential that descriptive data such as purchase order number, incorrect report number, kind of material, and similar information be stated on it. The procedure incident to inspection must vary greatly from plant to plant and industry to industry, depending on the plant organization and the nature of the material.

When the inspection report has been received, the storeroom should make out a "Material Received" report. It should preferably be made out in at least four copies and signed by the storekeeper. One copy should go to the balance of stores clerk who will check against the purchase order and make proper entries on the balance of stores sheet. One copy should be retained by the storeroom, while copies should be sent to the purchasing department and the accounting department to serve for checking invoices.

Handling materials returned from the shop. Materials returned from the shop comprise two classes, those which are returned because of necessary over-issue in the first instance and those which are returned because some change in the schedule or other complication makes desirable the prior processing of other orders than those for which the particular material was issued. With proper methods of issuing, usually only the exact quantities of material needed will leave the storeroom, but it is possible at times that over-issues must be made. For example, if bar stock is to be issued, it may be that the length called for on an issue slip is slightly less than the shortest piece in the storeroom. In that event, over-length must be issued. Small ends would be scrapped under such circumstances, but worthwhile amounts would be returned to the storeroom after the amount needed had been used. The simplest method of handling such over-issues is to have the storekeeper attach a tag marked "surplus" to the article, and retain a copy. If the surplus amount is returned he destroys all records; but if the surplus amount is not returned from the shop, he makes out an issue slip and sends it to the balance of stores clerk to be properly deducted from the amount on hand and be charged to the proper accounts.

If materials are not immediately needed as had been expected they should be returned to the storeroom and not kept on the production floors. When materials are so returned the storekeeper makes out a

"Stores Credit" (Fig. 119) and sends this to the balance of stores clerk. This slip serves to credit the order to which the materials have previously been charged, and goes to the cost-accounting section for that purpose, after the proper entries have been made on the balance sheets.

Receiving worked materials. Materials on which a certain number of processes have been performed, or components waiting assembly, must be received and stored until needed. The storeroom will handle these in the same general way as material purchased from vendors, except that no inspection will be needed, and the form on which receipt will be reported

MONTH DAY YEAR			AS-22			STORES CREDIT		
10	21	22						
STOREKEEPER:						CREDIT ORDER NO. <u>MX 422</u>		
PLEASE CREDIT THE FOLLOWING:						SIGNED <u>G. V. M.</u>		
SYMBOL		QUAN.	DRAW. NO. OR DESCRIPTION		WEIGHT	UNIT COST	TOTAL COST	
SS2C1F		3	11986					
ENT'D STORES TAG BY	MONTH	DAY	YEAR	STORES ABOVE HAVE BEEN RECEIVED		ENT'D INVY.		ENT'D COST
				STOREKEEPER				

Fig. 119.—Stores Credit.

will ordinarily be a "Worked Materials Received" slip, rather than a "Stores Received" slip.

Stowing. After materials for storing have been received and inspected they may best be placed on a rack or space devoted exclusively to materials awaiting storage in the proper bins or racks. There all materials may be tagged with their symbols or bin location. Some classes of materials should also be arranged in boxes or cans in suitable units for conveyance. The articles may next be arranged on a truck, in logical fashion, in order that they may be unloaded into their respective bins with the minimum of confusion and loss of time. As the specific articles are placed in their respective bins, entries are made on the bin tag, if there be one, setting forth the date and the amount.

MONTH	DAY	YEAR	AS-10
10	21	22	

STORES ISSUE

CHARGE ORDER NO. M 1318

STOREKEEPER:
PLEASE ISSUE THE FOLLOWING

SIGNED G.V.M.

SYMBOL	QUAN.	DRAW, No OR DESCRIPTION	WEIGHT	UNIT COST	TOTAL COST
SV1BH	100		17.6		
SVB4V	50		4.7		

ENT'D STORES TAG BY	MONTH	DAY	YEAR	STORES ABOVE HAVE BEEN ISSUED	ENT'D INVTY.	ENT'D COST
				STOREKEEPER _____		

FIG. 120.—Stores Issue.

it to prepare the material for issuance to the workplace in the factory in such time that no delay will be encountered between the existing job and the new one.

Both for purposes of accounting and storeroom operation simplicity, there are different forms provided, as illustrated, for the issuance of stores and of worked materials. From the physical standpoint of issuance in the storeroom, there is no difference in the action taken on the two forms. Figure 122 illustrates an effective stores card to be used in connection with tabulating machines. If this system be utilized, all cards may be printed in the same manner, and their various uses be designated by varying colors.

In getting out the material the stores issue man should, if possible, take enough issue tickets to make up a truck load at a time. Suitable tote-boxes may be placed on the truck to receive small materials. If the issue tickets are arranged in sequence, the issue man may move from row to row in the storeroom in as direct a line as possible. Immediately upon taking material out of a bin a deduction should be made on the bin tag, if there be one, and an identification tag, stating the material symbol order num-

AS 13 WORKED MATERIALS TAG NO.		CHARGE TO ORDER NO.	
M 13 P 9		C M 1416 413 P	
W	ISSUED FOR	1 M 1416 413 P	
QUANTITY ISSUED	UNIT	NUMBER PIECES	2
2	1	DRAWING NO.	
TOTAL WEIGHT	TOTAL VALUE	MACHINE NO.	
M-8003 T M-2007		ISSUE WRITTEN	MONTH DAY YEAR 6 22 1922
WORKED MATERIALS ISSUED		DELIVERED	19
STOREKEEPER		DO NOT FILL OUT NAME FOR ORDERS ON STORE- KEEPER.	
Mr. G		TO BEARER C	
PLEASE ISSUE ABOVE		SIGNED BY MAN FOR WHOM W. M. ARE ISSUED	
APPOR- TIONED	BALANCE SHEET	TAG	COST ACC'T
WORKED MATERIALS DESCRIBED ABOVE HAVE BEEN ISSUED			
SIGNED BY STOREKEEPER OR HIS REPRESENTATIVE			

FIG. 121.—Worked Materials Issue.

ber and destination in the shop, should be fastened to the tote-box or container into which the material has been put.

As soon as the material is delivered to a department in the factory it should be checked, preferably by the foreman, or at times by the individual workmen, to see that there is no shortage. Should there be fewer articles than are specified, a shortage report should be made out. Otherwise it will be taken for granted that the issue is correct, and any other issue for the same kind of material on the same production order will be contested

by the storekeeper. The cause of the discrepancy—error in stores requisition, error in issuing stores, material lost in moving, or material lost after delivery to the shop—should be noted, so that an additional stores requisition may be gotten out immediately to prevent any hold-up in production. The shortage may then be charged to the party responsible for the loss. Whatever the exact methods practiced, it cannot be too strongly emphasized that material should not be issued from the storeroom without a formal requisition.

The check or withdrawal slip used by depositors at banks is invaluable for accurately tracing the disposition of funds. Critics often say that such a practice in connection with the storeroom is red tape, and are eager to state that, in order to get a screw from the storeroom, a requisition must be written out, the cost of such a procedure would be more than the value of the article to be withdrawn. It must be remembered

RECEIVED															DELIVERED TO		
FORM NO. 1															DEPT. No.	EMPLOYEE No.	
MATERIAL															QUANTITY	AMOUNT	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DESCRIPTION OF MATERIAL															NOTE:		
															Use Yellow Card for REQUISITION		
															Use Pink Card for CREDIT MEMO		
															Use Salmon Card for DELIVERIES TO PART STOKES		
															Use Green Card for DELIVERIES TO FINISHED STOCK		
CLASSIFY															DATE		
REMARKS																	
TOTAL PLACES																	
CLASS AND OFFICE																	
RECEIVED BY																	
DATE																	

FIG. 122.—Stores Card for Use in Tabulating Machine.

that such a case is one fitted only for critical purposes. For practically all articles handled in the storeroom it will be well worth while to maintain a rigid control, and therefore no exception should be made for cases which will not involve more than a fraction of 1 per cent of the issuances. Office supplies and similar articles can be drawn in sufficient quantities at given intervals to overcome small issuances, a check being maintained in the office as they are issued to individuals.

Taking inventory. Where there is no scientific control of stores, physical inventories are the only check upon materials on hand, and hence are the only means whereby the profit or loss of the business over a given time may be determined. Although reliance on the physical inventory alone has largely passed from industry, there are still some companies which rely entirely upon it, and more which use it to supplement perpetual inventories. Its disadvantages may be summarized as follows:

(1) It is taken only once or twice a year because of the cost and inconvenience involved. (2) It is necessary to shut down the productive processes of the plant for the period during which the inventory is being taken. (3) Accuracy is usually impossible. Speed of taking is usually the paramount consideration, and no matter how highly organized the inventorying force, there are usually a number of omissions and duplications. This situation is intensified because clerks and shop workers who have no direct interest in the accuracy of the inventory, and who look upon it as a mean job, must be pressed into service to help in the count.

The second, and now practically universal basic method of inventorying is through a book record or running inventory, such as the balance of stores record already described. This gives a running inventory record of every article which is kept in the storeroom. Its advantages are the following: (1) The total inventory is found simply by taking off a trial balance of the stores ledger. (2) A record of the issuances of materials is afforded, and this may be followed up to see that the materials were actually used for the purposes for which they were withdrawn from the storeroom.

Although a perpetual inventory is provided, this does not usually mean that the taking of physical inventory can be completely dispensed with. Neither banks nor the Internal Revenue Bureau will accept unchecked book inventories, and from the standpoint of the business itself such practice would be unwise. A book inventory is never 100 per cent correct, and it is frequently far from this ideal, because of both clerical errors and unavoidable discrepancies between issues and issue tickets. In order to meet this situation there is provided some physical check of the book inventory. Such a check does not involve closing the plant to take inventory, but may be performed in one of the following ways.

One method is to check material as it reaches the minimum which has been set. Thus, in a hosiery mill, assuming that 5000 cones of a certain kind of mercerized yarn forms the maximum and 500 is the minimum, when the storekeeper has delivered 4500 on requisition for use in the shop, and the amount on hand has been brought to the minimum, he counts the amount actually remaining in the bin. He sends his count to the balance of stores clerk for comparison with the book record. The taking of physical inventory at the low limit requires little time and work. If there are bin tags, it can be done by the storekeeper on his own initiative as he notices that the balance on the bin tag has reached the minimum. If there are no bin tags, the balance of stores clerk can make up for him a daily list of articles which his records indicate have reached the minimum, and this list can be made the basis for checking. Special provision may be made for checking items which have not reached their low limit during

a period. Of course, in such cases, the maximum or ordering quantity has been set too high and should be corrected.

Another method that may be used for checking with book records is the progressive count. In the larger companies, one or two men, or as many as may be required by the particular business, may be engaged continuously in counting materials on hand. In a smaller plant the services of a clerk in his spare time each day may suffice. In either event, at given intervals of a few months, all the material is checked. Checkers start at one part of the storeroom and make the round of the department, checking all the items in a specific number of bins each day, and comparing them with the balance shown on the bin tag and in the stores ledger.

A book record, combined with a physical check similar to the above, assures accuracy of records, and makes possible not only inventory control, but the preparation of profit and loss statements at frequent intervals, such as monthly, or even weekly. Thus the business may be operated with information concerning actual conditions constantly at hand, and if leakages are occurring these may be stopped at once, rather than at the end of six months' or yearly periods.

A well-ordered storeroom and system of storeroom operation can be put in utter confusion by two days' use of lax methods. There will be frequently a temptation to depart from the procedure which has been set up because of a rush of incoming material, or because of a sudden need for certain material in the shop. The slight time saved for the moment in deviating from the standardized procedure will be more than overcome by the complications and losses which will ensue. It should be one of the primary objects of the storekeeper to see that he and his assistants, if he have any, rigidly adhere to the procedure that has been established. If he does this, and if he keeps the storeroom always in good order and condition, the inventory control which has been established will have an opportunity actually to function.

CHAPTER XL

PURCHASING DEPARTMENT OPERATION

INTELLIGENT purchasing department operation brings with it reduction of inventories, regardless of the position of the purchasing department in the organization, and regardless of the extent of its authority. To know markets and to know how and from whom to buy are primary functions of a purchasing department that it can always intelligently exercise. Its position and authority within an organization are varied, as was brought out when discussing "Organization To-day."¹ Upon the extent of its authority rests the extent of its control over inventories. It will, therefore, be well to review and to amplify what has been said with regard to the causes which bring changes in the position and scope of authority of purchasing departments from one organization to another.

Position of purchasing department in the organization. It sometimes happens that the purchasing end of a business is directly subsidiary to the selling end, or at least they go hand in hand. Such a case always exists in a manufacturing concern where there is a quick turnover of all raw material that is purchased, with only a slight additional process having been performed. This frequently occurs in markets which are highly organized, such as the cotton or flour markets. In these cases and others, where "hedging" is carried on to protect from loss, it is practically essential that the sales and purchasing ends of the business be under the same direct control. Of course this does not apply to the purchasing of supplies. An example of such a condition is to be found in the business of mercerizing cotton yarns, where the yarns are frequently bought and sold within a few minutes' time, and the mercerizing operation, which is all that is performed by the plant, adds but little to the value of the product.

There are many other types of businesses in which the manufacturing operations are more involved and relatively more important, but in which the position of the purchasing department must be one of maximum importance. Such businesses include most of the needle trades which purchase expensive fabrics, such as men's clothing. In such an industry, a very large share of the profit made during the course of the year is made from purchases at the right time or of exactly the right materials. Thus

¹ Chapter VI.

the cost of the material purchased is an important consideration in the authority granted the department.

The importance of the purchasing department in factories manufacturing complicated products may depend on the degree of standardization. If the product be standard, the scope of the purchasing agent's authority usually has been so limited by those who drew up the specifications that his task is fairly simple, and, therefore, one that is subject to general manufacturing control. If the product be not standard, the purchasing agent usually must decide many matters concerning the purchase of material which would not come within his jurisdiction with standard product. Hence, his position within the organization will be correspondingly increased in authority and importance.

Curiously, there sometimes develop, for very different reasons, violent objections on the part of general executives to clothing the purchasing agent with much authority. There are three such reasons which are worthy of mention. In the first place, there is the major executive who feels that there is "nothing to purchasing." He feels that his trouble has always been to sell his product, that other men are just as anxious to sell their products as he is to sell his, and that, therefore, the task of purchasing is comparatively simple. As selling has come to be more and more a scientifically studied vocation, the purchasing department has in self-defense provided the answer to this idea by employing means as scientific as those employed by the salesman.

Many major executives enjoy doing all important buying. Spending their money they find lots of fun, and they do not want a purchasing agent to do it for them. Besides, purchasing brings them into contact with other men in their industry in a way that almost no other phase of the business can do. These contacts, particularly if they have lasted over a period of years, frequently make of the purchasing agent a mere routine order-placer. There is usually a type of purchasing which, in any case, must be reserved for the higher officials. An illustration is the purchase of expensive equipment, such as machinery.

In assembly manufacturing, the third general cause for limiting the power of the purchasing agent is a very vital one. Decisions must be continually made whether to buy or make a certain part. The answer in any given case is likely to be influenced by the state of the market at the time, the manufacturing conditions in the shop, both in regard to the need for the product and the possibility of putting it through production, and the desire to build up outside sources of supply to fill future needs. General executives sometimes feel that they are the only ones who can pass on such questions. However, if the purchasing agent be competent, and if there be provided a committee organization with a main factory committee, such matters form an excellent subject for decision there.

The purchasing agent can be advised, under such circumstances, by factory and design representatives who may be present.

In the main, under modern organization, the purchasing agent works toward the quality which is specified by the engineering or design department, and the quantity which is specified by the production or planning organization. It has already been shown that most purchases will originate through the inventory control that is maintained at the balance of stores desk, and that this control will usually be exercised from the planning department. Much money is saved by providing for purchases only at times when there are production needs. The purchase of large amounts of material because they seem cheap, or because the price is probably going up, has not generally proved to be an economy.

Requisition by inventory control on the purchasing department makes it incumbent on the latter to know markets, be good traders, make purchases promptly, and follow up vendors effectively. If market conditions make a speculative purchase desirable, this may always be treated separately from the usual routine of purchasing, and in any case should form a subject for general executive decision.

The authority of the purchasing department with respect to finances must be limited in all cases. It must be operated on some sort of a budget system, whether or not this system has been adopted for the company as a whole. To require that all purchases be approved by the financial management of the concern too seriously limits the operation of the purchasing department, but to allow it to purchase regardless of the condition of the finances is manifestly impossible. The most effective means of controlling the financial end of purchasing work is through the operation of a general budget scheme, such as has been described. However, if there be no general budget, very effective purchasing budgets may be set up which will prevent inventories from mounting through improper purchasing operations, or through mistakes in running balance of stores sheets.

Sometimes, in the case of standard product, the purchasing department is allowed to purchase on the basis of the normal consumption for a given period, say, three months. They can purchase up to this point, and then further purchases can only be made on an allotment of further funds from the financial end of the business. In unstandardized lines, the purchasing department is given a budget of so many dollars per month, and they can buy any and every type of material up to the total of moneys so allotted them. After they have reached this point they must seek further authorization before buying more. Either of these budget methods forces the purchasing agent to keep very close watch on his finances to see that he may be able to purchase toward the end of his budget period.

Regardless of the position of the purchasing department in the factory,

there should always be some means provided for keeping the head of that department closely in touch with all conditions that may influence the course of his daily task, at least in the immediate future. Breakdowns in the operation of many purchasing departments can be traced to the fact that, owing to sudden changes of policy, which had been developing but of which they had not been apprised, conditions of requisition so changed over night as to make it literally impossible for the purchasing department to function properly.

A purchasing department, whatever the extent of its powers, has certain technical functions to perform. The purchasing agent must be an all-round man, in that he must be both an office man and a factory man. To operate a purchasing department successfully involves giving careful thought to office routine and office management. At the same time, the successful purchasing agent does not spend his whole time in his own office, but is careful to be frequently in the factory in order that he may become more familiar with its needs. By this means he assures a cordial reception for his purchases from the factory men.

The tasks of the purchasing department, for which it may be held closely responsible, always include writing specifications and letting orders for satisfactory material and equipment, securing it when it is wanted at the best possible prices and on the best terms of payment, and maintaining purchase records that are accurate and complete. The last-named task is by no means the least important, because it enables the others to be satisfactorily performed.

Drawing up specifications. One of the most difficult phases of purchasing department work is to draw up adequate specifications. The design or engineering department's requirements must govern, and yet the specifications must be in accordance with trade practice and trade terms. Specifications are most essential, if product is to be standard and if bids are to be asked for and compared. Much of the secret of good purchasing lies in drawing good specifications which vendors must live up to. This is a real money-saver, because it prevents a concern from paying for a brand or trademark name, which has been built up at high advertising cost, when the same article can be purchased elsewhere at less cost. In addition, purchases may be made on a level of quality which is just good enough and not too good for the purpose at hand. Purchasing on specification is not particularly popular with vendors who have in their regular selling price the cost of establishing their trademark, but all companies, no matter how small, can use it. Its only requirements are care in setting the specification and in inspection of goods upon arrival.

At times specifications may well be modified to suit the needs of the vendor. Thus slight and unimportant modifications of specifications may bring considerable reductions in quoted price because the revised

specifications will fall within the standard output of one or more of the vendors. Sometimes specifications are not determined by the buyer or by the vendor, but by the market. This is particularly true with those commodities which are subject to wide quotation, such as raw cotton, staple cotton yarns and cloth, or lumber. In such cases, the purchasing department can only determine the grade to be bought, and then see that the commodity as delivered comes within the market regulations for the grade ordered.

Specifications must always be set with primary reference to the manufacturing needs of the plant. Thus, one clothing firm found that by buying their fabrics in lengths of 200 yards, the cost was increased \$1000 per year, because such lengths were special with the vendors, but they saved \$10,000 per year in labor costs within their own plant. This factor was considered somewhat when standard materials were being discussed.

Knowing the sources of supply. The purchasing agent who makes most profit for his concern will generally be the one who is in touch with the greatest number of sources of supply, and who will get these most frequently into the bidding, either actively or indirectly. He will know the vendors who are in the best position to furnish given articles most cheaply, and he will constantly have in mind the various freight rates and discounts which will affect prices of the goods laid down at the factory door. Inviting competition is the surest way of securing the best possible prices. It is not the thought that bids should be secured every time there is an order for \$10 to be let. This is perhaps the surest way of arousing the wrath of vendors, and only large plants can successfully purchase on the basis of competitive bids under any conditions. However, the door of the purchasing agent's office should be open to any salesman who desires to see him. To give the idea that the door is only open to a few favored ones is to stifle competition and ultimately bring high prices. Salesmen are trained in their product and have ideas which are valuable to the purchasing agent and to the concern which he represents. To win the favor of as many vendors' representatives as possible is to have these men working for the interests of the plant also.

The purchasing agent of a large plant in the automotive field once cost his firm thousands of dollars because of his refusal to see a representative of a steel concern making a new, lighter steel which would have materially reduced the cost of a number of the parts of the product. Because he was in the habit of dealing through accustomed sources, he refused this salesman the opportunity of demonstrating the practicability of his product, and it was not until the latter could work through other friendly channels, some months later, that the engineering department heard of the newer steel and changed its specifications to permit of its use. The purchasing agent may be in constant touch with the newer develop-

ments of the trade, in just this way. He may be of invaluable aid to his company, and particularly the engineering or design department, not only through the judicious placing of orders, but through his knowledge of trade conditions.

Letting orders. In letting orders, it is essential that the purchasing agent shall know general market levels of prices, as well as the prices which he is being asked for particular materials. This will enable him to appraise better the quotations which he receives. He must have a thorough knowledge of discounts and datings which are current in the trade at the time, as well. Frequently, although reductions from list prices cannot be secured, the same effect may be gotten by an increase in the discount for cash. Particularly in times of tight money, purchasing agents who are clever can reduce the cost of purchases materially by this means. In order to know when to let orders, the purchasing agent must have a background knowledge of general business conditions. If he is not to be afraid of quickly rising or quickly falling markets, he must study trade reports and general reports of business conditions, which are readily available.

In letting orders, the purchasing agent who gives the vendor the most consideration on delivery dates will secure the most favors in the long run. Some purchasing departments have built up reputations for always putting the word "Rush" on orders. This is either disregarded by the vendor, or it puts the buyer at a complete disadvantage on price. If prices quoted are not affected on that order, they are very likely to be so affected on the next one. If the stores records are properly maintained, there will usually be no reason for asking vendors to rush most of their orders, and proper delivery dates can readily be set.

Some general managers keep careful watch over the relations of purchasing agents and vendors, with the idea that the purchasing agent is representing the company before a large portion of the business world, and that the impression which the trade will get of the company and its policies will largely be determined by the actions of the purchasing agent. With this in mind, restrictions as to methods of letting contracts are often put on the purchasing department by the general management. For instance, requirements as to the securing of competitive bids on large contracts are often imposed on the purchasing department quite as much on account of the impression which this makes on the remainder of the trade as to secure lower prices. Some companies will not allow the purchasing department to let contracts to another than the lowest bidder, without consulting some designated member of the general management.

Special purchasing problems of quantity production plants. In plants, such as automotive factories, turning out standard, scheduled production, the material control department and the purchasing department each

have a copy of the schedule to be met. Since they know what deliveries are necessary on each item, they decide on the quantities of materials to be bought at a time, and the particular time at which the material is to be delivered by the vendor. Consequently, in large automobile plants making several hundred cars a day, there may be only two or three days' supply of certain articles on hand. Failure to deliver material results in a direct reduction of the output of a department, and perhaps a stoppage of an assembly line. Consequently, the purchasing department must be doubly sure that it is dealing with reliable companies. Small differences in prices of material are of minor consideration in such cases. If orders are let to a vendor who fails to deliver, it usually means a higher ultimate price for some low-cost material, together with overtime work to keep the assembly lines from stopping.

Standing behind the purchasing decision. One of the most effective means of securing the long-run good-will and interest of vendor concerns is by standing behind the purchasing decision and not canceling in times of changing price conditions. The cancellation evil has come to be of great importance in some trades, and those firms which have a reputation of always taking what they order occupy a position which gives them the cream of materials and prices. Only a superhuman man can beat the market both up and down all the time, and it is usually better to win the good-will of important vendors than it is to cancel for the saving of a few dollars, providing cancellation be permitted. There are a number of ways in which vendors and salesmen can favor purchasers, such as in tips of forthcoming price adjustments and bargains in odd lots of usable materials. The company which does not cancel is likely to be the one which secures these favors. Furthermore, if frequent cancellation is the reputation of a company, it is likely to suffer from slow delivery, as the vendors will wait to assure themselves that the materials ordered were in reality wanted before placing them in process.

Purchasing records. The personnel of the purchasing department is ordinarily divided into two distinct classes, those actually performing the purchasing function and those in charge of the maintenance of purchasing records. In large purchasing departments both these groups become of considerable size, with one or more purchasing agents in charge of the purchase of various types of commodities, and with a number of clerks in charge of the various record-keeping functions, over whom there is a chief clerk who reports directly to the head of the whole department. The work of the group under the direction of the chief clerk is of paramount importance in successful operation. Records of past transactions, as well as of current ones, are vital to intelligent purchasing. In almost no other place in management are records of what has previously happened more vital. Information files, with complete and detailed information

concerning materials and vendors, can be made the very life-blood of the purchasing department.

One of the more important types of information which should be on hand, and readily accessible, is a list of manufacturers, dealers, or jobbers who are in a position to supply the articles which are regularly used, or who may be thought to be prospective bidders on any special commodities which may be required from time to time. All such information should be exceedingly complete to be of maximum value. It should include the location of the plant and the sales offices, the names of the officers to be dealt with, freight rates, any necessary remarks with reference to the freight situation between the point of shipment and the plant, such as congested junction points which may delay the shipment, and whether the concern is in a position to fill orders from stock, or must manufacture them to order. Other items of interest on these firm record cards should be facts regarding the manufacturing capacity or usual supplying capacity of the firm, and the maximum size of the orders that they can handle. Catalogues may be arranged by cross-reference to this list.

A quotation file should be maintained which will have readily available past quotations given by both successful and unsuccessful bidders. These files will ordinarily be composed of the returned "request for quotations," which have been sent out originally by the purchasing department, and will be valuable in checking over any new quotations which may be received, in settling disputes concerning reasons for granting previous orders to other bidders, and as a general bird's-eye view of the policy of the purchasing department with reference to the concerns which are invited to bid. This quotation file gives the complete history of all orders on which bids have been requested, prior to the actual filing of any of these orders. The next group of records, the actual purchase records, may duplicate some of this information, but this will not be harmful, inasmuch as when the information is wanted it will be most easily found as a quotation or as a purchase order, depending on the need at that particular time.

Purchase records are usually maintained in three ways in the most effectively run departments, namely, by firm name, by articles, and by purchase orders. The purchase records by firms include a sort of account for each firm with whom business is carried on. This record is used to check over receipts and invoices, as well as a record on which to base the issuance of future business. In maintaining this record of purchases by firms it is most essential that all discounts and datings be carefully noted, as these will serve as a check when purchases are next made from the company in question and are quite as important as the quoted sales prices.

Purchase records by articles are useful in showing the trends of prices and in discovering whether or not bids that are received are high or low. This last is particularly true in the case of commodities and articles for

which there is usually no stated "market." One error which is frequently encountered in this type of record and which must be guarded against is the placing of dissimilar commodities on the same card because of the incomplete description which is on the card or on the purchase order. This is just one more reason for making purchase orders extremely explicit. Slight differences in the article ordered may make the record of purchase by articles show fluctuations which are in fact not at all justified.

Purchase records are usually maintained in all purchasing departments by purchase order number, if in no other way. All shipments must ordinarily be marked with the purchase order number, and incoming goods are checked against the purchase order by the purchasing department prior to approving the invoice and sending it to the accounting department for payment. This type of purchase record usually consists of a retained copy of the purchase order, which copy will ordinarily have spaces for office record which do not appear on the original of the order that goes to the vendor. Such notations will include, "approved for payment," "expense distribution," "partial receipt," etc.

Another type of record which greatly increases the effectiveness of the operation of the purchasing department is the tickler follow-up of orders outstanding. This merely consists of a file, wherein special copies of the orders are placed, or separate slips bearing the order number are placed to be called to the attention of the designated person at a stated date after the papers are placed in the file. When these papers are called to the attention of the designated person, he makes an investigation to ascertain whether or not the material has been received, or what the progress has been in filling the particular order. By calling orders to the attention of a member of the purchasing staff at certain periods prior to the actual need of the material in the factory, it is possible to make certain that the material will be on hand when wanted, or at least that extra effort may be made by the purchasing department to secure it by the proper time. Thus the respect which the other departments of the organization hold for the purchasing department and its operating methods, will be maintained and increased. In operating the tickler file, a knowledge of the vendors' businesses are of great value. If the other man's processes are known, the purchasing department can often do much to hasten action on orders. Thus one plant which had ordered some artificial stone was told by the vendor that there would have to be a delay on the order, because all molds of the proper size were in use, and would not be available for several weeks. The purchasing agent replied that he understood that it was possible to make the material by using molds somewhat larger in size and lining them, and that if the vendor did not do this immediately, he would be forced to cancel and order elsewhere. This action quickly brought results in the form of a promise of delivery on time.

CHAPTER XLI

CONTROL OF PRODUCTION

Control through the line organization. Under any form of organization there must be some control of the productive process. In its simplest form this control consists of taking bills of material or specifications to the shops, and giving these to the foremen to be made up into the product. Such bills of material usually originate in the office of the superintendent, and it is to him that the foremen are accustomed to look for advice in manufacture, and, roughly, information concerning which job shall be done first. The superintendent's office, sometimes called the factory office, thus becomes the center of information regarding jobs that are to be done, and the general sequence in which they are wanted. In such organizations, it is customary to start the material through the manufacturing processes in some such offhand way, secure in the knowledge that it will come out ultimately at the other end of the factory in the form of finished goods. Attention is given a particular order while in process only as pressure is applied by the sales department or by a customer who may demand prompt shipment. Pressure is then put upon this order by the factory office, whose representative may frequently be seen stalking over the production floors, looking for the order or its component parts, and brandishing the sales telegram. When the order is found, everything is pushed aside to give it precedence, the requirements for delivery on the other orders are forgotten or go unheeded, and thus the groundwork is laid for a series of similar telegrams in the near future.

In plants which are operated through the control of the factory office, it is but natural that the orders on which there is pressure are the ones which receive attention. Unfortunately, unless the customer is very patient, or the goods being made for stock are in no real demand, pressure is usually applied sooner or later to nearly every order, and in each case where there is a need for pressure there is likely to be dissatisfaction created somewhere along the line. Plants which operate their production forces in this manner happily are passing rapidly. In those which remain there is likely to be a prejudice against the so-called "non-producers," and the general management would rather see ten men hired for direct labor on machines than to see one clerk hired so to control the work of the other direct workers that the ten new men would not be needed. Such unwar-

ranted prejudice can only be broken down through years of painful education in mounting production costs.

The simple production department. The first step toward controlling production usually has been taken through the creation of a simple production department, which is likely also to operate under the direct control of the superintendent. This department endeavors to decrease the number of rush orders, so far as this is possible, by the creation of a master schedule of production, on which all orders are listed with the date for their completion specified. Orders thus take precedence on the basis of the date when they are wanted. The creation of such a schedule implies the development of a manufacturing order system, such as is not implied by the lesser control exercised through the factory office. These manufacturing orders may or may not correspond to customers' orders, but will probably be issued to the shop to cover profitable manufacturing quantities. The orders will be issued at such time that the work upon them may be completed by the schedule date, but with this exception, the time of starting work on them will usually be left to the foremen of the departments. Besides noting the date wanted on the orders, there usually will be some broad division of these into classes which take precedence one over the other.

The simple production department usually provides for some sort of a progress report which will give daily or weekly checks of actual production against the schedule which has been set up. Thus the percentage of incompleting work and the capacity of the departments for further orders may be kept in mind. These progress reports give information concerning shortages of parts on various orders, and there is usually provided a force of "stock-chasers" who smooth out difficulties which may imperil the master schedule, as soon as these are seen to develop. The causes of shortages or delays may also be investigated and an attempt made to prohibit their recurrence.

This form of control deals almost entirely with problems involved in the dates when goods are due. It endeavors to eliminate production delays in order that products may come out of process when expected, and it thus forms the first and a very important step toward complete control of production. Since only the rough outlines of the production program are presented to the shop heads, it also must frequently act after the need for pressure has been discovered. That is, drift and check-up are still possible, and there are usually a large number of rush operations which develop and must be pushed ahead to the ultimate detriment of the whole production program.

Simple production department controlling staff work. After the creation of a simple production department, ordinarily it will be found that a large share of the delays in production are due to ineffective opera-

tion of those staff functions which relate directly to production. Such functions include shop transportation, tool-room operation, and maintenance of equipment. It therefore frequently becomes logical to place the supervision of these functions in the hands of the production department, in order to correlate their activities with each other and with the necessities of the production program. Although the emphasis of the production department is still on problems relating to dates when goods are due, nevertheless its control over these staff functions is a distinct step toward the creation of shop conditions which will insure goods being produced when they are due.

The planning department. The term "planning department" is often misused by being employed as a synonym for "production department." A developed planning department is far more positive in its action than is a simple production department and, on the other hand, a planning department may be only a portion of a larger production staff, the portion which does the thinking, or planning ahead. There may be other sections of the production department which aid in carrying on the developed plans of the planning section. The functions of the simple production department clearly do not include any systematic production control in advance of actual production. By far the greater proportion of its activities are of a check-up variety. That is, the department acts after it has found need for pressure at a given point in the production program. It does not act in such a manner that this need for pressure will be eliminated. It may receive back information regarding progress, but it does not give detailed advance orders as to what the progress should be at all hours of the day throughout the plant.

The operation of an effective planning department entails an effective check on production needs prior to the actual times that these shall arise. The planning department's operation makes impossible a policy of drift and check-up. The performance of its functions demands such a fine balance of management that it will not succeed unless many other preliminary management steps have been taken and are making themselves felt fairly successfully. There must be on hand sufficient information concerning the productive processes so that work may be honestly planned ahead with some assurance that the plans can be carried out. Furthermore, conditions of work must have been established which will give the plans an opportunity to succeed. Such steps include the setting of standards, the study of jobs, attention to layout, and effective employment management.

Elements of production controlled by planning departments. If a clear understanding be secured of the factors involved in the development of a planning department possessing the maximum of authority, it will be comparatively easy to see wherein certain phases of this authority

may be denied if deemed advisable, or are unnecessary in some types of manufacturing. Therefore, a planning department which has complete control over production will be assumed. Such control implies the centralization of control over four elements of the production process. These are (1) the manufacturing orders, (2) the material for these orders, (3) the productive equipment, including machinery, tools, and workplaces to be used, and (4) the workers.

Production planning takes these four elements, works with them, each in relation to the other, and operates through them in such a manner that the product is turned out in the time and by the method that is desired. The orders are the authorization for the performance of the work, and writing them carries with it an implication of co-ordination with the sales and financial ends of the business. The material comprises everything upon which work is to be done, whether it be raw stores, worked material, or components which are the product of another plant. The productive equipment comprises all machines, tools, and workplaces within the factory which are utilized for production purposes, and its control implies its utilization for such productive work as may be deemed best at a given time. The control over workmen is from the standpoint of the man who is to be assigned to the performance of a given task in connection with a particular order. All of these factors are co-ordinated by the planning department, so that a series of operations, based on needs of the manufacturing orders, upon capacities of equipment and workmen, and upon condition of material, are developed. These operations are then laid out, supervised and correlated in such a manner that work will proceed through the plant in the smoothest and most orderly fashion.

There is no work performed by the planning department which should not be performed by someone under any circumstances. The centralization of all similar effort under one head is but the application of the functional idea to the task of planning for production. The centralization of all planning work not only insures that it be done, but that it be done by qualified persons in a way which will be of most benefit to all within the organization. The planning department provides an opportunity for the accumulation of centralized knowledge and a utilization of this knowledge which is manifestly impossible if the planning function be unorganized and scattered among many men located in many departments.

To establish a planning department involves taking over from line members of the organization control over (1) when work is to be done, and, within limits (2) where work is to be done. The extent of control that it may exercise over these phases of the plant's activity must necessarily vary with the plant and product. In determining when and where work is to be done, the planning department performs management functions

TYPE	CONTROLS								
	Rush Orders	When goods are due (including Manufacturing Order Writing, Master Schedule, Progress Reports)	Production Staff Work (e.g., shop transportation, stores)	When Orders Start	Workplace Where work is done. (Routing)	Despatching	Department where work is done and Despatching between departments	How—Job Study	Inventories
Factory Office (Line Control of Production)	X								
Simple Production Department	X	X							
Simple Production Department Controlling Staff Work	X	X	X						
Planning Department		X	?	X	X	X	X	?	X
Production Department with Planning Section		X	X	X	X	X	X	X	X
Production Department with Decentralized Planning		C	X	C	D	D	C	X	X
Production and Planning in Quantity Production		X	X	X	L	L	L	?	?

X = Function performed

C = Function performed in Central Planning Department

D = Function performed in Shop Planning Units

? = Function may be performed

L = Layout eliminates performance of function.

FIG. 123.

Chart Showing Functions Controlled by Various Types of Production Control

which have been given definite technical names, the use of which will clarify any description of the work of the department and eliminate confusion of terminology. These functions are routing, scheduling, and despatching. Routing includes planning where and by whom work shall be done. The routing work of a planning department prescribes the path which work shall follow and the necessary sequence of operations, particularly in building up an assembly product. This work involves such close analysis of facilities that frequently layout is affected. In quantity production plants where machines can be set up so that each performs one or several operations in direct sequence, the routing function is directly a part of plant layout. The routing section must have at its disposal all standards that have been set by job study for the operations and for shop methods. Scheduling involves the planning of the amount of work to be done and when each element of the work shall start, or the order of work. This includes planning for the quantity and rate of output of the plant or departments and also the date or order of starting of each unit of work at each station along the route prescribed. Despatching involves the meeting of schedules by proper utilization of machines, workplaces, materials, and workers, as designated by the routing. The despatching unit of the planning department thus includes all persons whose duty it is to see that orders are issued to the shop, that materials are at the work place, that tools are provided, job cards issued, and, in general, that all necessary steps are taken to insure that the schedules be properly carried out.

The operation of a planning department implies the control over staff departments that is sometimes found with the simple production department, and, in addition, the planning department may have control over job-study work, and usually inventories.

The production department with planning as one of its divisions. In large plants the planning department is usually found as a part of a larger production organization. This structure involves no radical change in the functions or methods of operation of the planning forces. Such an organization has been depicted already, in the typical organization chart discussed in Chapter VI. The staff functions of production may be entirely controlled directly by the production department, or they may be controlled partially by the planning department. In the latter case, such functions as maintenance and job study would be controlled by the production manager, while the balance of stores desk and shop transportation would probably be controlled by the planning department.

Decentralized planning control. The earlier planning departments sought for entire centralization of the various planning functions.⁶⁷ In small concerns this is without question the desirable ideal, but in large factories decentralized control usually is found. A central department

correlates the activities of the various individual planning units, which are usually located in each of the producing departments of the plant. Under decentralized control the foreman is controlled by the planning department, and the planning clerk in each department may report either directly to the foreman or to the planning department. In any case he will report to the central planning department functionally. By this system the central planning department retains control of production from raw materials to finished stock, and at the same time in large plants its schedules and plans become more flexible and more readily adjusted to day-by-day and hour-by-hour happenings in the shop. This type of planning control merely provides for the removal of some of the detail planning work to the departments, without in any way reducing the correlation of major activities of the plant. The central planning department still controls the schedules and the despatching between departments. The planning supervisor in each department controls despatching within the department. Routing may be carried on in the place which seems most desirable under given plant conditions.

Decentralization of planning control brings with it relief from certain dangers which centralized control constantly must guard against. These are similar to those involved in taking the general management of a plant away from the four walls of the factory and locating it in a distant city. It is easy to get out of touch with departmental or plant conditions. It is easy to lose that co-operation of the foremen and subforemen, upon which depends, in a large measure, the success of planning work. If these men feel that orders are being sent to them for mere execution, and that the management of the plant is around them rather than through them, the planning forces are likely to lose their all-essential support. Although with central control the foremen should be in and out of the planning department all day long, decentralized control enforces the aid of foremen in planning. Thus, not only is the information collected by the experts of the planning department available, but that mass of technical information concerning production which has been accumulated by the foremen through long years of direct contact with the job can be utilized. Decentralized control should not involve supervision of clerical detail by the foreman in sufficient quantities to affect his capacity to produce. The foreman must necessarily be the responsible administrator of his department, and a certain amount of supervision of clerical detail gives him accurate information upon which to work.

Factors influencing type and authority of planning department. The extent of the authority of the planning department, be it centralized or decentralized, and the whole method of constructing its organization, must vary with the conditions of the business. These factors will govern: (1) the type of management existing, (2) the type of manufacturing in

which the concern is engaged, and (3) the size of the plant. The influence of this last factor has just been noted.

All phases of management development influence the operation of production planning work. The methods of organization, the development of standards, the extent of job study, the presence or absence of an administrative budget procedure, are all important. A good illustration of the effect of the type of management on the outlines of the planning department is found in the extent of the job studies that have been made. Job study is by no means an essential prerequisite to the operation of planning control, but the minuteness with which planning may be carried on will be dependent directly on the extent of job-study data. Without job study large allowances must be made in planning work.

Planning department organization is directly affected by the nature of the product manufactured. The scope of the work and the details of operation in the following industry types must of necessity be different:

1. An assembly industry manufacturing diverse products.
2. An assembly industry manufacturing standard products.
3. A continuous industry manufacturing diverse products.
4. A continuous industry manufacturing standard products.
5. Minor variations of these, especially with reference to the length of operations.

Planning departments vary in organization far more in relation to some such division of industries than they do in relation to products manufactured. Planning problems in clothing and metal-cutting manufacture or in paper and standard textile manufacture are essentially similar. But the planning for production in a flour mill and in a lock factory have few similarities. In continuous industries manufacturing standard products on a quantity basis, the scope of the production or planning department is far different from what it is in the jobbing shop. This will be discussed in detail in Chapter XLVI. It is sufficient to indicate here that by giving adequate consideration to plant layout, the problems of routing and despatching between operations have been eliminated to a great extent. It is to the schedules that most planning attention must be given in such plants.

In assembly industries manufacturing diverse products is found the most involved planning department organization.

Does production planning pay? The objection that it involves large extra expenditures for clerical labor is sometimes voiced to highly developed planning work. It does involve clerical labor. That it does not involve unreturned expense is proved by the experiences of those who have installed elaborate planning departments and have had them operating for some years. Clerical overhead may be increased, but shop overhead

is often decreased. One plant increased production 62 per cent and reduced overhead 21 per cent at the same time. It is not necessary that the small plant have a different person perform each function that has been or will be described. On the other hand, in large establishments, many workers are needed to handle the detail of planning. There is no fixed number of people or fixed arrangement of functions possible in organizing a planning department.

Production planning is the answer to greater production on the same investment without unduly speeding up workers. One plant now has \$2,000,000 less tied up in inventories than before its planning department functioned. Another reports that it would have gone bankrupt with the decline of material prices in 1920 if it had had as much inventory on hand as would have been necessary without its planning department. Effective planning always means effective control of detail. It is this detail, properly co-ordinated, which makes not only for an even flow of production, but for accurate costing. This detail must be built into an effective routine without red tape.

Although the development of a planning department must fit the individual needs of the particular plant, nevertheless there are certain planning ideas which can be universally applied, and it is these that will be considered in detail. In considering this detail, an assembly industry manufacturing diverse products will be described first. Since this presents the most intricate planning problems, it forms the best basis for discussion. After considering planning work for this type of industry, the necessary modifications for other types will be discussed, and will be easily visualized. The procedure outlined can only be looked upon as a typical and well-developed one, the details and even the broad outlines of which always must be modified to fit particular conditions.

CHAPTER XLII

ROUTING

The scope of routing. Routing is preliminary to most other production-planning steps. Including as it does the planning of where and by whom work shall be done, the determination of the path that work shall follow, and the necessary sequence of operations, it forms a groundwork for most of the scheduling and despatching functions of a planning department. Only the development of the master schedule and the issuance of manufacturing orders precedes it. The scope of routing may be well subdivided as follows:

1. The analysis of the finished article from the manufacturing standpoint, including the determination of components in case it is an assembly product. Such analysis must indicate the materials or parts needed, whether or not they are to be themselves manufactured for an order, or whether they are to be found in stores, either as raw or worked materials, and quantity of materials needed. Much of this work may have been done by the engineering or design department in drawing up the specifications for the product, but these must be studied and checked from the production standpoint.

2. The fixing of the sequence of completion in manufacture that one part, or piece of material, bears to another, in order that all may be brought together as needed in the process of manufacture.

3. The determination of the operations which must be performed at each stage of manufacture, and where these shall be performed. This implies a division into such operations as will utilize to the best advantage both the skilled and the unskilled members of the factory's production force and all equipment. It is here that the results of job studies are of great importance. The actual selection of machines and workmen after operations have been determined upon is that portion of the routing function that is most frequently performed decentrally.

4. The division of total quantities required into proper manufacturing lots or batches. This must be done with due reference to length of operations, space occupied by the material while moving through the shop, and the requirements of the master schedule.

It is the performance of the routing function which perhaps most clearly distinguishes the work of the planning department from that of the

simple production department. It must be evident that practically all the work of routing concerns production control in advance of actual production. Why routing is desirable may be well illustrated from the problems of a textile plant manufacturing woven fabrics from a number of raw materials. In fabrics such as tapestries, the cloth may be composed of thread silk, spun silk, rayon, worsted, and cotton yarn, all in a large variety of colors. In such materials as madras shirtings, the number of materials may be fewer but the colors equally numerous. Some of the yarns or colors in either case may be required in large lots and others in small quantities. Materials which may be needed in small quantities on one order may be used in large amounts on another. If the looms are to be kept operating continuously, all preliminary operations must be performed on each class of materials so that it will be ready for production on any order as needed. Some of these operations will have to be started a few days ahead of actual weaving, while others must be begun a month ahead. In order that schedules of production for each of the materials may be worked out, the extent of their use must be known far ahead, and the best utilization of machinery considered both in relation to these materials and the products in which they are to be used. Similarly, in manufacturing an assembly product, such as a lock, there are a number of small components, each of which must be provided in adequate amount prior to any attempt to make either subassemblies or the finished product. The raw material comprising each of these components must be put through a number of manufacturing operations prior to being available for subassemblies, and decision must be made concerning the most economical operations and machines for the manufacture of each component with due consideration to other current demands on the workmen and equipment of the shop. Since a padlock is a product which is of common usage and whose components are fairly well known; and, since its manufacture clearly demonstrates the need of routing and planning work in general, it will be used largely as the basis for illustration.

There is some manufacturing in which the work performed in the plant is so extremely simple, and the product is so uniform, as to require only a very simple routing mechanism, if any, after the plant once begins operations. For instance, a flour mill which operates day after day and year after year on the same type of raw material, turning it into the same type of finished product, would have but little need for an elaborate system of routing. However, even with standard product, there are usually several types manufactured; some components or materials take longer to work up than others, and thus numerous problems of routing and machine utilization arise. Although routing work is easier with standard products, still it must usually be performed as a part of current production planning.

Inter-relation of routing, classification, and layout. In its application, routing is closely bound up with two management steps previously discussed, classification and layout. Routing and classification should be interdependent. A skeleton classification for stores, worked materials, and finished stock is of great assistance in developing routing work. And, as the route of a product is determined, components analyzed, and operations fixed, the subdivisions of a classification develop and may be recorded on the classification sheets. Ease of routing will be greatly enhanced if material symbols and operation symbols are so devised that they may be used directly in the work of routing and included in the routing instructions which are issued by the planning department.

Use of bills of material in routing. Routing work in a planning department begins on the receipt of a manufacturing order from the proper authority. It must necessarily be based upon the bill of material or specifications which are received from the engineering or design department. As indicated in the accompanying illustration (Fig. 124) of a section of the specifications for a padlock (see Fig. 92, p. 232) this will usually give a list of the components of the product, together with specifications of the material from which they are to be made, manufacturing tolerances in case of machined parts, and frequently a list of the operations to be performed on each component. This last item may be left entirely to the production forces; but if it is, close contact must be maintained between the two departments to insure that designs do not involve unnecessary manufacturing complications.

Not only must complete specifications for the finished material be on hand before routing be attempted, but there must be much additional information available. On operations which have been previously performed, job-study data should be available for reference, and on new operations job studies must be made and the results reported back to the planning department. If there be not time for job studies on new operations, then the advice of the job-study man must be secured concerning the routing of the work. He will be able to give much valuable advice from his knowledge of equipment capacities. It must not be inferred that the route man may be ignorant of the shop equipment. If routing is to succeed, the route man should be the person in the whole shop organization who knows most concerning manufacturing method. Nevertheless, he may secure much that is valuable from the job-study man and the results of his work. If routing to particular machines is to be attempted, some record of available machine capacities must be at hand. This may take the form of a rough record of the relative amount of work that is being given to each machine. Such a record will prevent preference always being indicated for some particular machine or machines if alternate choices can be made, and will enforce a consideration of the whole equip-

Part	Number Required	Kind of Material	Size of Material	Gross Weight of 100-Pec. Lb.	Operation
DOG	1	Drawing steel	.075×2 $\frac{1}{4}$ ×C plus and minus .002	1.9148	Pierce and blank Sort Form 1st operation Light rumble in sand Form 2nd operation Rumble in sawdust Countersink dog tube hole Caseharden (done outside) Copper plate Brass plate Rivet dog tube Deliver to PS.
CASE STUDS	5	F. M. Yellow Brass Rod	.187D×11' plus and minus .001	.7286	Form and cut off Whiz Rumble in sawdust Deliver to PS.
BOLT SPRING POST	1	F. M. Yellow Brass Rod	.187D×11' plus and minus .001	.5283	Form and cut off Whiz Rumble in sawdust Deliver to PS.
SHACKLE SPRING POST	1	F. M. Yellow Brass Rod	125D×11' plus and minus .001	.2442	Form and cut off Whiz Rumble in sawdust Deliver to PS.
DOG STUD	1	F. M. Yellow Brass Rod	.156D×11' plus and minus .001	.4759	Form and cut off Whiz Rumble in sawdust Deliver to PS.

FIG. 124.—Section of Specification Sheet or Bill of Material.

ment of the shop on those in charge of routing. This record quickly indicates the approximate amount of work that the routing has at any time assigned to each machine or class of machine in the shop. In order to promote flexibility of despatching, alternate machines should be indicated in the routing wherever possible, but where there is a cost advantage in the use of one machine over another, this should be shown by designating clearly the preferred machine. Frequently, because of the nature of the operation, no preference can be shown.

Preparation of the route sheets. From the data at hand the route sheets and material for the route file are prepared. Route charts may also

SYMBOL <i>P2 1/2 H1 B</i>		DRAWING NO. <i>50936</i>		DATE <i>4/7/23</i>	WRITTEN BY <i>F. E. W.</i>
DESCRIPTION <i>Back, 2 1/2" Heavy Duty Padlock</i>					
QUANTITY IN LOT <i>20,000</i>		MATERIAL <i>SV 1083 x 2 15/16 SCR</i>			
TIME PER PART, MIN.	PREP. HOURS	NUMBER	OPERATION DESCRIPTION	MACHINE NO.	ROUTE OPERATION PREF. MACH. SPECIAL INSP.
			Material Apportioned and On Hand		
		1	Blank & Pile (Together with P2 1/2 HSM)	PA17	
		2	Form & Stamp	PD7	
			To Process Stores		
		3	Pierce	PD9	
		4	Straddle Mill Shackleyway	MP8	
		5	Rumble in Sawdust	T2	
		6	Grind burrs on top	G7	
		7	Punch Shackleyway Heel	PH4	
		8	Punch Shackleyway Nose	PH5	
		9	Planish Shackleyway	PD22	
		10	Trim	G4	
			To Process Stores		
		11	Rumble in Sawdust	T2	
		12	Sandblast	X8	
		13	Ebony Black Rustless Finish	X11	
			To W. M. Stores		

FIG. 125.—A Route Sheet for a Component.

be prepared, as will be illustrated. Route sheets, as will be noted from the accompanying illustrations (Figs. 125 and 126), list fully the materials that are necessary for a given operation, the complete list of operations in sequence, and the machines on which these are to be performed. In addition, for despatching purposes, the standard time for each operation may be given, and check spaces are provided to record the progress of the order through the shop. Different types of route sheets are usually needed for components and for assemblies, because of the different nature of the operations involved. Material for the route file comprises all the necessary tickets and forms used in despatching the order through the shop, as provided for by the production-control system and the operations that have been listed.

Route sheets serve two purposes. They indicate, for scheduling and

despatching purposes, the necessary operations to be performed, and the place where they are to be performed. Through the check columns, they provide a progress report which will give at any time the status of any component, assembly, or order that is in manufacture. Furthermore, since only one lot of material is governed by a single route sheet, the work is divided up definitely into the proper lots or batches which have been determined upon as desirable from a manufacturing standpoint. Assembly route sheets must show clearly the sequence of assembly operations, particularly whether the operation may be performed independently or simultaneously, or must be performed in sequence after another assembly operation, because it depends on the product of the latter for a portion of its material. To illustrate, in the assembly of a padlock (Fig. 126), the assembly of the back is composed of one independent and

SYMBOL		DRAWING NO.		DATE		WRITTEN BY					
P 2 1/2 HB		50935		4/1/20		F.E.M.					
DESCRIPTION		Back Assembly, 2 1/2" Heavy Duty Padlock				QUANTITY IN LOT 20,000					
TIME FOR OPERATION	DRAWING NUMBER	CHECK			ASSEMBLY OPERATION			STORES AND OTHER MATERIALS NEEDED FOR EACH OPERATION			
		PERMANENT	ACCIDENT	NUMBER	DESCRIPTION	LOCATION	MOVIE OPERATION	FIRST TIME	FINAL TIME	QUANTITY	DESCRIPTION
		✓		1	Rivet Case Studs & Bolt Spring Post	R1				1	P 2 1/2 HB
										1	P 2 1/2 HB
										1	P 2 1/2 HB
		✓		2	Rivet Shankle Post	R2				1	P 2 1/2 HB
		✓		3	Rivet Dog Stud	R4				1	P 2 1/2 HB
		✓		4	Rivet Shankle Spring Post	R5				1	P 2 1/2 HB
					To W.M. Stores						

FIG. 126.—An Assembly Route Sheet.

three successive operations. These last operations, dependent on the first assembly having already been performed, can be carried on only in sequence. On a parts route sheet, it is only necessary to indicate one lot of raw material upon which the various operations are performed in sequence. On an assembly route sheet it is necessary to show what additional material is needed for the performance of each operation, as material may be added at various points in the assembly process.

Combination routing. Because of particular manufacturing conditions, it may be desirable to have two batches of material routed together for a certain distance through the course of manufacture, and then split. Or it may be desirable to bring together two or more batches of material at given points in the manufacturing process, although in the main they will follow separate courses. Such conditions usually call for combination routing, which provides for the routing of the various batches so that their relation one with the other will be clearly evident. An example of the necessity for such routing is found in assembly industries not making

standard products, in which materials must be brought together at various stages in the process to insure that rivet holes and other similar points which must come into direct contact in the finished product will match. To provide for this, the various components of the finished product must be routed co-ordinately in such a way that they will go through a number of operations separately and will then be moved as the next operation to some central point, in order that the rivet holes may be matched. They may then break apart again and go through various other operations prior to being brought together again in assembly. Combination routing is also provided for several jobs in production, which may use the same set-up on any machine. In order to save time and set-up cost, these jobs will be routed in combination.

Preparation of tickets for despatching. A portion of the routing function usually includes the preparation of the route file, which includes all tickets needed for planning and despatching work during the course of the order in the shop, such as time and job tickets, issues for worked materials and stores, operation orders, inspection tickets, and move tickets or tags. These tickets, which are usually written in the main by some duplicating process, are suitably taken care of by some filing scheme until they are needed for despatching. Sometimes they are all placed in pockets in a specially constructed file, which will contain all route sheets and papers pertaining to one manufacturing order. Thus the route file will contain information concerning the path that that order is to take through production, plus all necessary forms which will be utilized in despatching, working, paying for labor on, or recording costs, for the order, plus the necessary columns on the route sheet to accurately record the progress of the order. To these often will be added tool lists to be sent to the tool room as given operations are called up in the process of despatching, and instruction cards to be issued to the workmen as the operations are to be performed. Route sheets are at times arranged in the form of a visible index, so that they may be easily referred to by the despatcher, in which case the necessary forms are filed close by in boxes or tub desks (Fig. 127). The use and issuance of the various papers which are prepared will be described under the order of work and despatching procedure (Chapter XLIV).

Close inter-relation of routing and scheduling. Although routing presumes the best possible utilization of equipment, still it is desirable in routing work to observe closely the conditions of the plant schedules, and not leave too much leeway in the selection of equipment and too much of the adjustment function to despatching, which is largely a routine, clerical job. In routing, an attempt is always made to prevent the utilization of a large, expensive machine for a small job that can be done on a small machine, and yet if the schedule of work is not providing operations for the large machine, and is overcrowding the small one, the route man must

PHB ■
 SPRING POST
 RS
 4 PHD
 BACK GROUP
 ASSEMBLING PH ■

CP2½H ■

— HEAVY DUTY PADLOCK (2½") —

BACK GROUP PHB
 DOG : PHD
 BOLT : PHL
 TUMBLER : PHT
 MISCELL : PHM

PHIM ■

PHAM ■

Assemble all parts, rivet
 FRONT and inspect
 Dr 50935

WB

PHSM ■

PH6M ■

50933 PH2M

50936 PH3M

IPH ■

ASSEMBLING PH ■

Wrap LOCK in PAPER and
 pack one LOCK in a BOX
 Dr 50935

VB

ASSEMBLING PH ■

Put LABEL on BOX
 Dr 50935

VB

FINISHED
 LOCK

1 ■ 22 PAPER
 1 ■ BOX

5/22APM

5V4MC

SB

2PH ■

SPH7M

To Store

S10

SPH ■

To face page 149

take this into account in designating the path that material shall follow. Although he desires always to use the machine that is best fitted for a particular operation, still there is ordinarily no object in having machines idle while others have jobs waiting. The machine record already referred to will aid in correlating scheduling and routing, and if the route man has an opportunity to study a report of idle machines which gives reasons for idleness, it will aid him in routing with the needs of the schedule in mind.



FIG. 127.—Route Sheets (in foreground) and Machine Boxes (in rear, along wall), Universal Winding Co., Providence, R. I. (Note the boxes containing despatching forms, located below the route sheets.)

Use of route charts. Standard route charts, which set forth graphically, in definite order, the operations, materials, machines, and grades of labor required to make a finished product in the most economical manner, are utilized frequently (Fig. 128). They serve as a permanent record, and as a guide in the drawing up of route sheets for individual orders. They are most practicable with standard repetitive product, but can be used profitably in any plant where the sequence of operations is similar, although particular operations may vary. On such charts the operations are so set forth that their sequence is made perfectly clear, and, in the

case of assembled products, that the sequence of assembly of the various parts is carefully shown. All independent groups of the finished product are so separated that those operations which may be performed independently may be seen at a glance. The amount of information which is placed upon the chart may best vary with the needs of the plant. Generally the following information is included: materials needed, with symbols; operations, with numbers; and best machines or equipment for their performance. At times alternate machines are designated upon the chart, in which case the estimated relative costs of performing the operation, on the alternate machines may well be included in order to eliminate the tendency to utilize the most costly machine. The original of the attached chart was a blueprint, as is usual. Hence the black squares in the illustration were white spaces in the blueprint. These spaces allow for the writing in of operation numbers, lot numbers, etc.

- Combination schedule and route charts provide for the charting of all operations and assemblies in proper sequence upon a scale, which is so computed toward the left from final assembly that reference to the chart will indicate exactly when any component must be placed into production. This chart is so devised that the necessary operations upon components and the subassemblies into which they go may be performed in time to have them meet with other components for semi-final or final assembly on schedule. Such a chart is extremely valuable if shop conditions permit of a smooth flow of work. Sufficient time must be allowed between operations, in laying out such a chart, for goods to be inspected and moved. This time is usually arbitrary and the same for all operations and departments. It must be so regulated that orders will move at the greatest possible speed, to prevent unduly large inventories of material in process, and nevertheless so that there will be a factor of safety remaining. Many production control boards have been worked out on this principle, and are in reality only such a chart in board form.

CHAPTER XLIII

SCHEDULING

SCHEDULING production provides for the setting of beginning and completion dates for each manufacturing order or portion of a manufacturing schedule, and for the determination and rearrangement of the order of work within the shop so that the completion dates may be met. The most familiar form of schedule control is that of the railroads. The processes of industrial scheduling are essentially similar. Predetermined schedules control the operations of the offices of railroad dispatchers. Similar schedules control the dispatchers of industrial production. In developing the railroad schedules, limited, express, and local passenger trains, through freights, and way freights must all be placed upon the schedule in such a way that they may utilize the same tracks most effectively. Provision must be made, through the dispatcher's office, to schedule special trains, and to rearrange schedules or sequences of operation as trains become late and peculiar circumstances interrupt the ordinary conditions of operation. Factory scheduling involves essentially the same elements. There are regularly scheduled orders to be taken care of, each of varying importance. Then there are special orders and special conditions to be met, as shop conditions change or as the regular schedule is interrupted. The equipment of the factory is almost as limiting to the passage of orders, one around the other, as are the rails of the railroad. And orders must be scheduled and schedules must be changed to meet conditions, if the demands of production and the requirements of sales are to be met. That is the function of scheduling.

There are two distinct phases of production scheduling. The first is a carefully drawn master schedule which indicates the relative importance of manufacturing orders. This may be developed prior to or coincidentally with routing. The second is the determination of the order of work, or the exact order of operations of each portion of each order that is performed at a separate workplace. This phase of scheduling follows routing in performance, and is carried on either prior to or coincidentally with despatching. The determination of the order of work is primarily a scheduling function. The operation of the order of work is primarily a despatching function. Inasmuch as they are frequently carried on coincidentally, it is difficult entirely to separate discussion of the two.

However, in so far as they may be separated, the understanding of the planning function in its elements, rather than in a particular installation, will be clarified.

Master schedules of production. In scheduling production, manufacturing orders originating from direct customers' orders, or as a part of manufacturing budgets, must so be arranged that the plant may be operated at its maximum manufacturing effectiveness. If possible, each productive unit should so be provided with work as to allow it to be operated continuously. But, primarily, sales requirements must be met. The work of scheduling comes into more direct contact with the sales department of the business than does that of the other planning functions. General policies regarding the relationships of sales and production are determined by the general management, by budget meetings, or by the daily contacts of the production manager and the sales management. In large plants, the production manager may deal more with broad policies than with specific sales orders. In such cases the arrangement of the production schedule may be entirely a function of whoever is in direct charge of scheduling production. Manifestly, in small plants, the production manager will himself directly control scheduling.

In the development of a master schedule, it is essential that there be careful co-operation with the sales department, not only that information concerning sales needs from the delivery standpoint may be considered, but also that information concerning prospective orders may be secured. This is particularly necessary in cases in which a plant manufactures both to customers' orders and to stock. This indicates that if the production manager does not directly control scheduling, the one who does must sit, along with the production manager, on such committees as deal with the co-ordination of efforts of the sales and production departments.

Issuance of manufacturing orders. Manufacturing orders, based on the master schedule, will usually be issued as a part of scheduling work. These orders may be subject to subdivision into economical manufacturing batches by the one in charge of routing; nevertheless, they will usually be issued with full consideration of this factor. A single manufacturing order may cover only a portion of the manufacturing budget for a particular article, or it may combine two or more customers' orders for the same article. Thus small customers' orders or large stock orders are increased or subdivided into profitable manufacturing quantities. The shop does not care who gets the finished product. It does want to know how much is wanted and when it is needed. This usually is stated on the manufacturing order, and the due date which is placed upon it corresponds to the sequence on the master schedule. An effective manufacturing order blank is illustrated in Fig. 129. It is thus clear that the master schedule must be so arranged as to indicate (1) the due date of all orders, (2) group-

Master schedules—plants manufacturing to customer's order. There is no hypothetical grouping of classes of orders that will be fully satisfactory in any and all plants. Nevertheless, those in charge of scheduling must be governed by the same general considerations, regardless of the plant. In plants manufacturing primarily to customer's order, these orders will be seen to subdivide themselves into some such general classes as the following: rush, regular, repair, and stock. Any order falling into

FIG. 129.—Manufacturing Order, Lewis Mfg. Co., Walpole, Mass.

Rush orders include those which are received with necessary delivery dates so stipulated as to make these prior to the time at which the product would naturally be completed in the ordinary course of production. Whatever the desires of executives, this class of orders seemingly never can be completely eradicated. Rush orders also come to include those on which there has been a tie-up somewhere in the production process, which has thrown the individual order back of its previously determined schedule. By regular orders are meant customers' orders which are received with

delivery dates specified that fit into the usual requirements of factory production. Such orders ordinarily take precedence over repair orders on goods already sold, although there may be circumstances when these latter will come even into the rush class. If there are many repair orders, they may be put through on an entirely different manufacturing basis, and, in large plants, in different departments from regular orders. Stock orders are usually utilized to fill in the voids between orders intended for certain customers. They cover staple products, for which there is a constant demand.

Master schedule—plants manufacturing to stock. The sequence of classes of orders must necessarily be different in a plant which manufactures primarily to stock. The development of product standardization within recent years has greatly increased the number of such plants, and the spread of the idea of the administrative budget will further increase them. In a factory that manufactures a variety of standard products for stock, from which customers' orders are filled as they come along, there is usually developed a production budget or "demand estimate procedure." This carefully drawn estimate of production needs, such as has already been discussed, serves as the basis for the development of the master schedule. If a plant be on such a manufacturing basis, it has achieved a flexibility of scheduling such as is not possessed by the factory which operates primarily to customers' orders.

The manufacture of materials for stock implies even a closer liaison with the sales department than does the production of orders directly to fill customer's demand. It also implies a closer relationship with the policy control of the company, since, in order to schedule product which has not yet been sold, it is necessary to have a definite knowledge of future company sales and production policy, as well as a knowledge of the financial affairs of the plant. It is not to be assumed that those in charge of the preparation of the master schedule will have all of this knowledge. They will, however, be governed by their demand-estimate procedure, which will have been so worked up as to include this detailed knowledge of company policy whether or not there be a general budget.

Companies which wish to avoid production tie-ups, and which operate on the basis of manufacturing to stock, usually have their schedules developed months in advance. Unless there is some arrangement made whereby these schedules may be readily changed, it is very likely that financial difficulties may be encountered because of the working capital which is tied up in material. The close liaison necessary between the scheduling function and the balance of stores function must be evident. There must be continual conference between those in charge of these two phases of control.

In manufacturing to stock, customers' orders are usually regarded as

special and not allowed to interfere with the regular schedule. However, the rush order still persists. It is probably clear that the necessity frequently arises, during the progress of an order through a shop, to change it from one status to another, thereby changing the precedence accorded it.

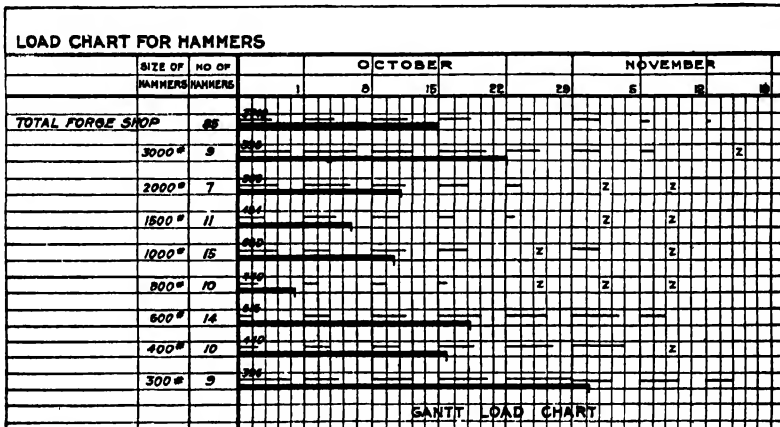
The master schedule should not be looked upon as something rigid into which a new order finds a definite place upon its receipt in the shop, that place never to be changed. On the contrary, it should be regarded as a continually flexible piece of shop mechanism, which is changed week by week, perhaps day by day, as conditions change with the receipt of new orders, the completion of old ones, or the development of some new condition in the shop.

Master schedule based on standard hourly production. If job studies or analyses of machine capacities have been made in detail, data can be worked out which will give the standard hourly production for a given machine or a given department, or on a given operation. These data may be used to set up a master schedule. If the product be standard it may be desirable to set up a schedule board that will give in detail the time of starting and stopping of each major operation on each part which goes into the product. It is wise to set up such a board on the basis of something less than 100 per cent efficiency. Progress reports which come from the production departments may then be checked with the master schedule that has been set up, and the order of work changed to rectify any undesirable conditions.

On unstandardized, diversified product, the master schedule may be set up in terms of hours of work ahead on given classes of product. Such information, which may be termed the balance of work ahead, can be easily communicated to the sales department. In making sales, the sales department can deduct the time required for their manufacture from the balance and thus can always know the unfilled capacity of the plant which it may sell. Means of filling unsold capacity in special work can be discussed at meetings of the general factory committee or in other suitable conferences. Such a program involves determining everything in terms of hours of time it takes to produce product, by departments. The sales department must be kept constantly informed concerning this. In a sense the sales department sells departmental time rather than products, and the scheduling work is concerned with time rather than with products. The operation of such a schedule is greatly facilitated through the use of a load chart which will indicate unapportioned capacities by departments and types of machines.

The load chart. The creation of a schedule based on standard hourly production, and the ability of a sales department to keep manufacturing departments constantly supplied with orders, is greatly enhanced through the use of Gantt Load Charts, similar to the illustration (Fig. 130). This

chart was prepared by Mr. Wallace Clark and is reprinted by permission from his book, "The Gantt Chart."¹ It illustrates the scheduled load of a forge shop. The first line of the chart indicates the total work ahead of the shop, by weeks and as a grand total. The other lines indicate the amount of work scheduled ahead for each class of hammers, by weeks and in total. The figures, 396, 308, etc., indicate the weekly capacity of each group of hammers, based on a 44-hour week. Thus the chart indicates that the 3000-pound hammers have enough work scheduled for them the first week to keep them busy 80 per cent of the time, as indicated by the light line, while for the week ending November 5 only 40 per cent of their capacity has been booked, and zero has been booked for the week ending November 19. In general, if material and tools were available, these ham-



Courtesy, Wallace Clark and The Ronald Press.

FIG. 130.—Load Chart for a Drop Forge Department.

mers could continue steadily for four weeks on orders already booked. The shop as a whole had 50 per cent of its capacity booked for the first week and a total of three weeks' work ahead.

Master schedules in quantity production plants. In quantity production plants, as indicated in Chapter XLVI, the master schedule merely consists of a statement of the number of units of production to be produced in a given month, week, or other production period.

The order of work. The preparation of the order of work differs from the development of the master schedule, inasmuch as it concerns itself with detailed operations of manufacture of a product, rather than with the completed product. The control exercised by the master schedule throws emphasis on bringing the final delivery date to such a point as to coincide with the needs of the sales department. The development of the order of

¹ "The Gantt Chart," Wallace Clark, The Ronald Press, pp. 77-80.

work should control the step-by-step progression of the work through the factory in such a way as to bring the finished product through the process of manufacture at such a time as to meet the needs which have been set down by the master schedule. Changes are but infrequently made in the master schedule as compared to changes in the order of work. The latter feels the ebb and flow of factory conditions. A particular machine may be broken down, a particular workman may be out, and these may change the order of work on another machine or for another workman, in order that the needs of the master schedule may be met. On the other hand, such small recurring factors do not in any way affect the master schedule.

In the development of the master schedule, the orders must necessarily be arranged in accordance with their relative importance. In arranging the order of work, the operations must be arranged in such a way as to consider the amount of work which must be done on each and the conditions which exist in the shop, as well as the date when the final work on each order must be completed.

Progress charts as an aid in scheduling. The method by which the scheduling division receives the information on which to base changes in its order of work is through the creation of a system of progress reports or progress charts. These give up-to-the-minute information concerning the progress which has been made on various orders that have been started through the process of production and which, therefore, have already been given a place in the order of work. If progress charts indicate that any order or any part of an order is falling behind the schedule, steps are immediately taken to advance this order or section of an order to a higher position in the order of work.

The Gantt progress charts. The most effective type of progress chart is the Gantt Chart. The two accompanying illustrations are reproduced by permission from Mr. Wallace Clark's book, "The Gantt Chart."² Figure 131 represents a progress chart used in a machine shop manufacturing to customer's order. The angle opening to the right indicates the date on which each item was to be issued from stores; the figures indicate the numbers of the operations to be performed on each order and are placed under the dates on which they were to be begun, and the angle opening to the left indicates the date on which the parts were to be shipped. The heavy lines indicate what operations have been performed on each order, and the letters under the lines indicate the reasons for delay. The R under order 59064 indicates delay due to repairs, and since the chart indicates the time needed for the remaining operations, adjustments in the schedule can be made by the production manager to meet existing conditions. The V indicates that this chart was reproduced on March 3. If the work had

² "The Gantt Chart," Wallace Clark, The Ronald Press, pp. 87-94.

the work done to the time of the preparation of the chart by the heavy line. Work done prior to June 1, when the chart was drawn up, is indicated by the dotted lines. Z signifies zero for the month. On part 1463-BR the sales schedule was set at 1200 per month. However, the amount of sales during the first three months fell short of this estimate. There were 960 in stock when the chart was drawn and during June 1050 were received, in July 720, and in August 1440, or a total of $3\frac{1}{2}$ months' normal usage, as indicated by the heavy line. Deducting sales, $1\frac{1}{2}$ months' normal usage is found to remain in stock. The heavy line on manufacturing orders placed indicates that this covers $2\frac{1}{2}$ months' normal usage beyond the articles already placed in stock, while the number of forgings on hand is sufficient for more than another half-month's production.

It is necessary that this check-up by means of progress charts, or similar devices, be made a continuing process and one that is always kept up to the minute, because parts of assemblies, or whole orders, which once get very far behind schedule usually will throw many others out of schedule if the effort is made to bring them back into position. The effect of having to put extra pressure on one order is usually to require placing at least slightly extra pressure on a number of others later. Promptly to check up orders falling behind a carefully worked-out schedule keeps the whole shop on its toes. For instance, if the delay is due to the failure of material to arrive, there should be an automatic check on the man who has the job of getting the material in. If the delay is due to equipment out of commission, there should be a strong pull on the superintendent or the maintenance man to give his personal attention to that particular portion of the equipment.

Scheduling and the plant executives. It will be well to understand the relationship of the foremen of the shop to the order of work. With centralized planning, the foreman comes into contact with the order of work but infrequently. In decentralized planning, it is often the foreman who makes out the order of work for his own department. In centralized planning it is most necessary that the foreman be given the responsibility of taking up with the planning department any order of work which he may feel is illogical.

The work of scheduling heads up in reports given to the works manager and other major executives of the concern. Besides a "balance of work" or "load ahead" report, which indicates unapportioned capacities, reports at periodical intervals may be made by the scheduling division which show:

1. A detailed list of all customers' orders in process.
2. A detailed list of all stock work in process.
3. A detailed statement of causes of delay or changes in the order of work which have held up production and which may be remedied or bettered by executive action.

CHAPTER XLIV

OPERATION OF THE ORDER OF WORK AND DESPATCHING IN DIVERSIFIED MANUFACTURE

To operate the order of work is to signify clearly for each machine or workman the sequence in which jobs are to be performed, based on the needs of the master schedule and conditions in the shop. Despatching includes the execution of all the plans of the routing and scheduling sections of the planning department. It largely consists of transmitting orders to the shop, is carried on coincidentally with the operation of the order of work, but is purely a clerical function. Although, except in large plants, the operation of the order of work and despatching are likely to be carried on by the same individual, for clarity of illustration they will be spoken of as if handled by two persons.

Central operation through the use of planning boards. In order to understand clearly all factors involved in these phases of production control, it will be best to consider first one basic system. This system will presume central operation of all phases of planning in a shop wherein the nature of the product and orders make necessary complete control of each separate operation. The type of jobs and size of lots will be varied and such that the operations will be long enough to make such control profitable, and yet short enough to allow at least three jobs to be planned ahead of each machine or workman. Changes in these basic conditions would necessitate changes in the system devised, as will be indicated later. This system will indicate the factors in production which must in some manner be controlled by the order of work and despatching. It will be described in full detail, including all forms which are necessary for its operation. The factors include the workmen, the equipment, raw and worked material, tools, instructions, inspection, and shop transportation. To study this system is particularly valuable because it clearly controls each of these factors separately, and thus clarifies systems which combine control over several factors in production. The fundamentals of this system are probably used in more planning departments than those of any other, and many other planning systems are clearly developments which use this one as a basis.

The greatest aid in operating an order of work is some sort of continuous visual check on the condition of the shop. The type of check here

described is known as a bulletin board, or planning board (Fig. 133). Through the operation of this bulletin board or its equivalent, those in charge of the order of work and despatching have always before them an accurate picture of shop conditions, and through the added aid of the route sheets, the status of all orders. The planning-department bulletin board pictured is known as the three-hook type. Pairs of hooks are arranged in vertical rows in sets of three for each machine or work station.

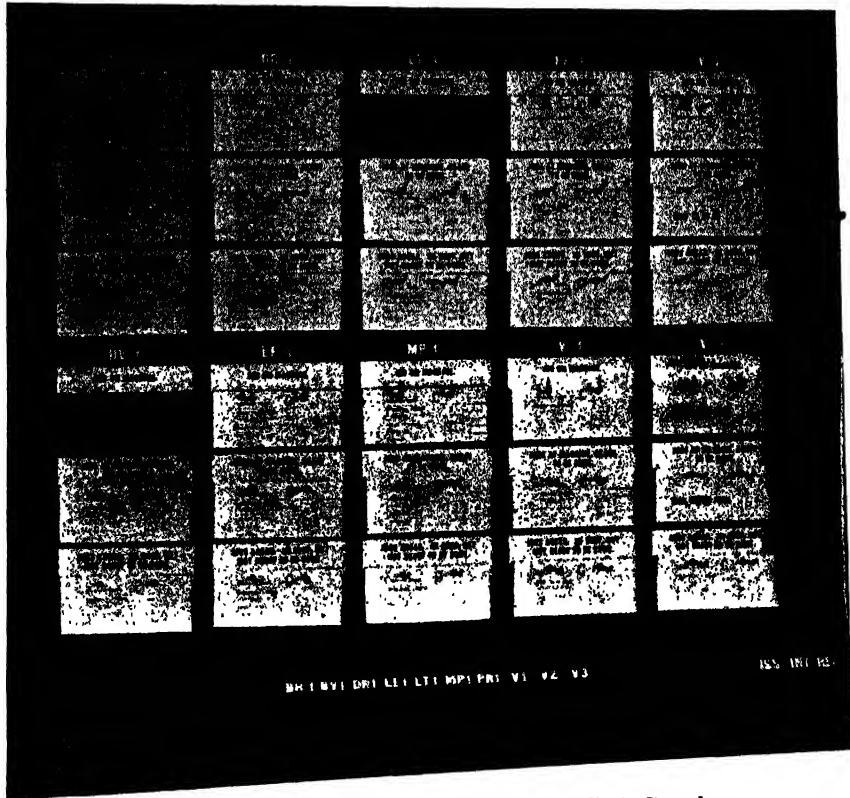


FIG. 133.—Section of Planning-department Bulletin Board.

Each pair of hooks is utilized to indicate the position of work in the shop with respect to that particular machine or workplace. These hooks will be referred to hereafter as the first, second, and third hooks, and represent work in the following conditions as regards the machine or workplace: The first hook represents work which is on the machine. The second hook represents work at the machine ready to be done. The third hook represents jobs ahead in the shop and tentatively assigned to the machine or workplace, but not yet ready to be done.

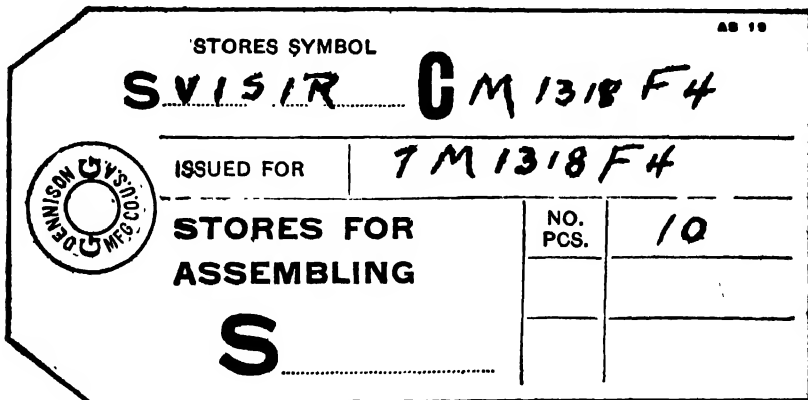
The lower portion of the board consists of a number of small compartments, one for each of the work stations shown on the board, and other compartments for miscellaneous uses. The compartments in the center of the board correspond to the machines or work stations which the board controls, and are utilized for filing tickets, relating to work assigned to the particular machine, in the manner hereafter described. The three compartments to the right are used for temporary filing of tickets that control the issuance of tools, drawings, and instructions, as will also be described. The other compartments may be used for miscellaneous purposes.

In each department of the shop there will also be found a shop bulletin board (Figs. 138 and 139) which will portray information concerning work for each machine or workplace in that particular shop. This shop bulletin board may be looked upon as a replica of that section of the central bulletin board which deals with that particular department. It is set up in the department for the purpose of more readily correlating the activities of the shop foreman and the central planning department, and does not imply, in any way, decentralized planning. The method of arranging tickets on this board will be spoken of later.

Indicating the order of work. The order-of-work man is constantly working toward the master schedule. He will determine from this the time at which it will be necessary to place an order or a component of an order in production. He must consult the route sheets pertaining to the order for the path to be followed through the shop. In operating the order of work, he must constantly consult the route sheets, since any determination of the time when an operation is to be performed must rest largely upon the availability of the machines or workmen involved. When an order is to be started, he must first consult the route sheets to ascertain whether material is available. He will determine this by consulting the checkmarks which have been placed on the route sheet opposite the heading, "Material apportioned and on hand" (Fig. 125, p. 446). In case he is dealing with an assembly operation he will consult the assembly route sheet (Fig. 126), and there ascertain whether the necessary material has been checked, "O.K." All such checks will have been made by the balance-of-stores clerk, who, since he controls stores, will have been in a position to place this necessary information on the route sheets. If material is available, the order or component may be placed in production.

To place an order in production involves taking certain of the despatching tickets, which were prepared at the time the order was routed, from the files, and starting them through the routines which they affect. These will include stores issues, identification tags, and move tickets. The stores-issue forms were partially considered when the operation of the store-room

was described. (Figs. 120 and 121, pp. 419 and 420.) They are prepared from the route sheets, and filed after they have first passed through the hands of the balance-of-stores clerk. The latter at that time utilizes the information upon them to increase the apportioned column of the proper balance sheets, correspondingly to decrease the available column, and to take such other steps as may have been made necessary, as, for instance, to order materials. When the order-of-work man removes the stores issues from their file, they again pass through the hands of the balance-of-stores clerk. This enables him to write off the material which is being issued from the "On Hand" and "Applied on Orders" columns. The task of forwarding stores issues to the storeroom is a function of despatching. Usually, it is only necessary for the order-of-work clerk to place the issues in a designated place, which will indicate to the despatcher that these slips



The form is an identification tag with a header section and a table section. The header section contains the text "STORES SYMBOL" followed by the handwritten code "SV151R CM 1318 F4". Below this is a horizontal line with the text "ISSUED FOR" followed by the handwritten code "7 M 1318 F4". To the left of the "ISSUED FOR" text is a circular stamp that reads "JOHN HENSON SYSTEMS". Below the "ISSUED FOR" text is the text "STORES FOR ASSEMBLING" followed by a large handwritten letter "S". To the right of the "STORES FOR ASSEMBLING" text is a table with two columns: "NO. PCS." and a blank column. The table has three rows, with the first row containing the handwritten number "10".

STORES SYMBOL	
SV151R CM 1318 F4	
ISSUED FOR	7 M 1318 F4
STORES FOR ASSEMBLING S	NO. PCS.
	10

FIG. 134.—Identification Tag.

are to be forwarded to the storeroom and the corresponding orders thereby placed in production.

At the same time that the despatcher sends a stores issue to the storeroom, he sends along with it the necessary number of stores identification tags, which have already been prepared and filed (Fig. 134). Such tags are attached to all stores issued and stay with the materials throughout the production process, thus clearly identifying them, with the production order on which they are being used. The move ticket (Fig. 135) is now sent by the despatcher to those in charge of interior shop transportation, as authority to move the material in question from the storeroom to the department and production center where the first operation is to be performed. If the route sheet indicates alternate machines on which a given operation may be done, the writing of the move ticket is at times left to the despatcher, and he will select the machine by consulting the

planning board as to availability. Identification tags and move tickets are often profitably combined in a manner later explained.

The set of check columns on the route sheets used for recording the performance of designated operations now comes into play. The columns are headed "move," "operation," "first inspection," and "final inspection."³ A check is made by the despatching clerk when he orders the

DM 14	C M 1318 F4		
IN OUT			
PIECE SYMBOL		SVISIR	
MOVE THIS MATERIAL AS DIRECTED: W _____ S _____	NUMBER PIECES	10	
	DRAWING NO.		
	MACHINE NO.	BH 1	
FROM <u>Stores</u> ON <u>—</u> FLOOR TO <u>BH 1</u> ON <u>—</u> FLOOR			
WORKMAN'S NAME _____ MAN'S NO. _____ DM _____			
ROUTE SHEETS	PAY SHEET	COST SHEET	I HAVE MOVED THE MATERIALS AS ORDERED ABOVE SIGNED _____

FIG. 135.—Move Ticket.

performance of any of these functions on any operation indicated as necessary by the route sheet. For instance, when he issues the move ticket and orders the materials from stores to the first operation, he might draw a vertical line halfway down the small space under "move" and opposite the first operation, thus indicating that he has ordered this action. When the move has been completed, those in charge of shop transportation return the move ticket to the planning department, noting upon it that

³ See route sheets (Figs. 125 and 126), pp. 446 and 447.

the move has been made. This information might then be posted by the despatching clerk to the route sheet by completing the vertical check under move and opposite the first operation. Anyone who might consult the route sheet would, therefore, be informed immediately as to the status of

IN OUT	15 OPERATION ORDER C M 1318 F 4			
	OPERATION SYMBOL		7 MF	
	TO EARN BONUS, WORK MUST BE DONE IN	2.48	NO. PCS.	10
	AMOUNT OF BONUS		DRAW. NO.	53748
	WANTED FOR		MACH. NO.	BH 1
	HOLD FOR			

FIG. 136.—Operation Ticket. Planning department bulletin-board copy (white), shop bulletin-board copy (manila).

that particular order at that time, namely, that the material was at the machine ready for the first operation, but that this operation had not yet been performed.

Immediately upon receipt of information in the planning department

DRAWING AND INSTRUCTION CARD ISSUE	DM 8 OPERATION ORDER C M 1318 F 4			
	OPERATION SYMBOL		7 MF	
NUMBER OF INSTRUCTION CARDS		1	NO PCS.	10
NUMBER OF TOOL LISTS		1	DRAW. NO.	53748
ISSUED BY	RECALLED BY		MACH. NO.	BH 1
SIGNED	SIGNED			

FIG. 137.—Operation Ticket. Drawing, tool, and instruction card issue copy (pink).

that material has been moved to a production center, the scheduling function with respect to indicating the order of work again becomes important. At the time that the order was routed, there were placed on the third hooks of each machine or workplace affected by the order, triplicate copies of an operation ticket (Figs. 136 and 137). This ticket

describes and controls the operation to be done on that machine in connection with that order. The tickets hanging on the third hooks will at any time clearly indicate the balance of work ahead of each machine or department not yet placed in production. If alternate routing to a group of machines is provided by the route sheet, the operation tickets usually will be hung on the third hooks of one machine of the group previously designated. When material is moved to a production center, the order-of-work man must remove the proper triplicate set of operation tickets from the third hook and place two of these in proper sequence on the second hook. *The position in which he places them on the second hook will determine the order of work for that operation on that machine with reference to other operations already scheduled for the machine.* He will determine the position according to the needs of the master schedule. The two copies that are placed on the second hook are the planning-department bulletin-board copy (Fig. 136) which will primarily control sequence (white in color)⁴ and the drawing, tool, and instruction-card issue copy (pink in color) (Fig. 137). At the same time that these two copies of the operation order are placed upon the second hook, the manila or shop bulletin-board copy is taken to the shop board and placed there.

The shop bulletin board illustrated in Fig. 138 consists of two sections: on the right a series of pairs of hooks serially numbered; on the left a series of clips under headings for each machine or work station in the shop. When the shop copy of the operation order is placed on the shop bulletin board, it may be hung on any one of the serially numbered pairs of hooks which may at the time be vacant. At the same time that this operation order is placed on this pair of hooks, there is placed under the machine heading a strip of cardboard on which is found a number corresponding to the serial number of the hooks on which the operation order is hung. The relative position of this strip of cardboard to other similar strips under a machine heading indicates the order of work for that particular machine, and corresponds exactly to the order of work as found on the second hooks of the planning-department board. Another form of shop board, used at the Universal Winding Company, as illustrated in Fig. 139, provides for the placing of operation orders in sequence directly under the machine numbers. Either method gives the necessary flexibility of operation.

Conditions of a particular shop will determine the number of operations for which material should be on hand at any production center, and also the number of these for which tools, drawings, and instruction cards should be on hand. Unless the tools be special, they will be used on more than one operation, and it is, therefore, not wise to have too many waiting at the production points. The pink operation ticket controls the

⁴ Any color combinations may be used.

issuance of the tools, as well as the drawings and instruction cards; and on shop conditions, and on the number of jobs ahead of a machine will depend largely the handling of this ticket. It may not be placed upon the second hook at all, but may be used immediately to order the tools, drawings, and instruction cards to the shop. Or, if there are a number of operation tickets on the second hooks, it may be placed on the second hook

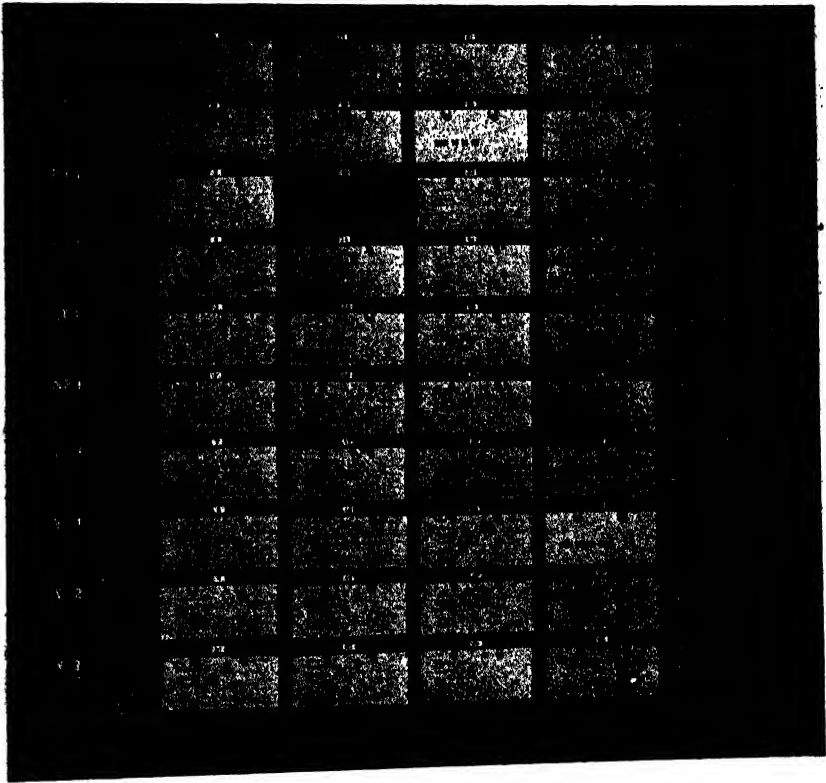


FIG. 138.—A Shop Bulletin Board.

with the white operation ticket, as already indicated, until it is the second or third job ahead. In any case when it is desired that the tools, drawings, and instruction cards be issued, the pink operation ticket is placed in the small compartment in the lower right-hand portion of the planning board marked "ISS" or issue. These tickets are periodically collected by a messenger, who, consulting them, takes the proper instruction cards and tool lists from the files and any necessary drawings from the drawing cabinet to the work station. The tool lists are subsequently forwarded

with the requisite number of tool checks by the foreman to the tool room, as a requisition for the necessary tools for the operation. This procedure insures the utilization of standard tools for the operation. The pink ticket is then filed in the central section of the bulletin board under the machine number, thus indicating that the instruction cards, drawings, and tools are at the machine and the operation is thus ready to be performed.

Despatching to the workman. Let it be assumed that a workman has

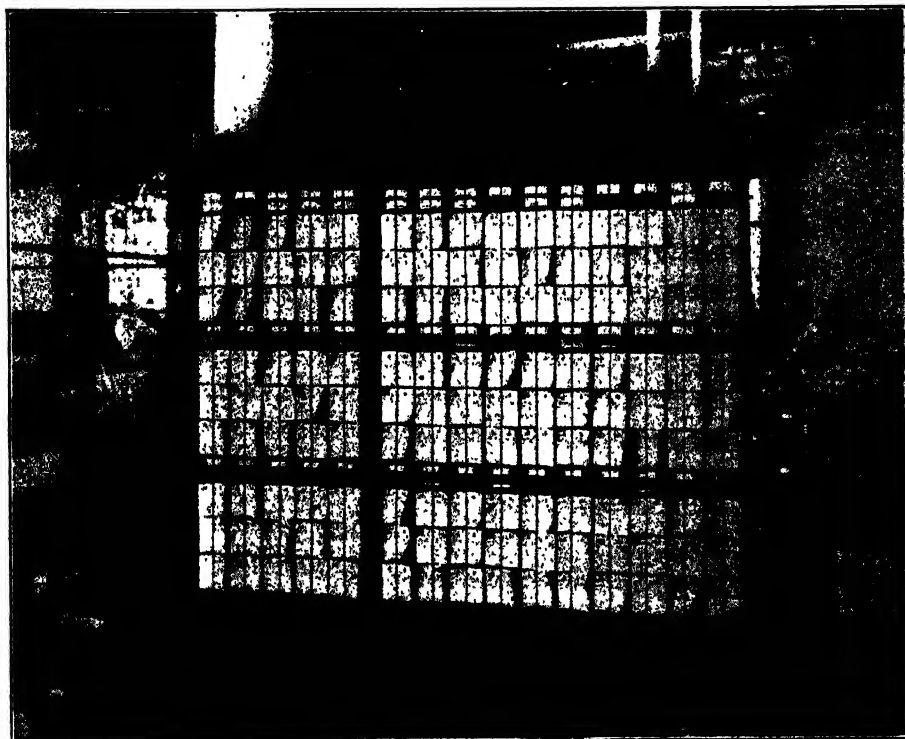


FIG. 139.—Shop Foreman's Bulletin Board, Universal Winding Co., Providence, R. I.

just completed an operation on a machine. He brings or sends to the despatch window of the planning department the time ticket (Fig. 140) which had been issued to him at that same window at the beginning of the operation. This time ticket is stamped with the time of receipt and the workman is ready to receive a new time ticket for his next job. The despatcher consults the bulletin board and ascertains which job is next on the order of work on the second hook of that machine. He places this operation ticket on the first hook after removing the operation ticket for the job just completed. He then proceeds to the route file, removes the time ticket and inspection ticket (Fig. 141) for the new operation,

hands the time card to the workman, and forwards the inspection ticket to the inspector. At the time that the despatching clerk hands the time ticket to the workman, he draws on the route sheet a half check line under the headings "operation" and "first inspection" for that particular task. At the time that the workman brings back his time ticket, indicating that the work has been completed, the despatcher completes this

DN IN OUT	<div style="font-size: 4em; float: left; margin-right: 20px;">C</div> <div> FIRST TIME CARD AND BONUS RECORD M 18 24 4 J P 1 </div>									
TOTAL WAGES \$		OPER- ATION SYMBOL		4 M J P						
MACH. TIME	TIME ALLOWED	BONUS TIME	BONUS WAGES	No. PCS.		50				
	3.25		\$	DR. No.		36452				
IF JOB IS NOT FINISHED SCRATCH OUT THIS F			IF JOB IS FINISHED SCRATCH OUT THIS NF			MACH. No.		BH 1		
DAY									TOTAL	
PIECES FINISHED										
TIME UNITS										
WORKMAN'S NAME					MAN'S NO. DM-					
I HAVE CHECKED THESE ENTRIES AND BELIEVE THEM TO BE CORRECT:										
HRS. X COST No.					SIGNED BY FOREMAN					
ROUTE SHEETS	PAY SHEET	COST SHEET	BONUS EARNED BONUS NOT EARNED							
THE ABOVE WORK HAS BEEN INSPECTED AND FOUND O. K. DEFECTIVE										

FIG. 140.—Time Ticket.

check line. After the inspector makes his first, or check, inspection, the inspection ticket is returned to the despatcher who completes the check line under first inspection. This use of the route sheet as a progress chart clearly illustrates the desirability of having it filed in such a manner as to be readily accessible.

Upon receipt of the time ticket from the worker at the completion of the operation, the inspection ticket is reissued to the inspector for recording of final report as to quality and number of the lot that is good and can be continued in process, and a half check line drawn under that column.

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Upon receipt of the final inspection report from the inspector, this line is completed. The time and inspection tickets are now forwarded to the rate-setting or cost department for addition of bonuses, deduction of penalties, and general payroll purposes, as well as for entry on the necessary cost records.

Upon the receipt of the final inspection ticket from the inspector, the pink operation order controlling the drawings and instruction cards is

DM IS IN OUT	<div style="font-size: 4em; margin: 0;">C</div> <div style="margin: 0;">M 18 24 4 J P 1</div>															
FIRST INSPECTION		OPER- ATION SYMBOL	4 M J P													
I HAVE INSPECTED THE WORK DONE ON FIRST PIECE AND FIND AS FOLLOWS:				No. PCB.	50											
ROUTE SHEETS	MAN'S NO. DM			DR. No.	56482											
SIGNED BY INSPECTOR				MACH. No.	BH 1											
FINAL INSPECTION: I HAVE INSPECTED THE WORK DONE ON ABOVE OPERATION AND FIND AS FOLLOWS:				PIECES DELIVERED TO MACHINE	PIECES LOST AT MACHINE											
				PIECES DAMAGED EXTRA WORK												
PIECES DAMAGED NO EXTRA WORK	PIECES SPOILED AT MACHINE SCRAPPED	PIECES DAMAGED STOCK	PIECES SPOILED STOCK	DEFECTIVE CASTINGS	PIECES O. K.											
<table border="1" style="width: 100%;"> <tr> <td>ROUTE SHEETS</td> <td>BONUS RECORD</td> <td>PAY SHEETS</td> <td>MAN'S COST SHEET</td> <td>PRODUCTION RECORD</td> <td rowspan="2">SIGNED BY INSPECTOR</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>						ROUTE SHEETS	BONUS RECORD	PAY SHEETS	MAN'S COST SHEET	PRODUCTION RECORD	SIGNED BY INSPECTOR					
ROUTE SHEETS	BONUS RECORD	PAY SHEETS	MAN'S COST SHEET	PRODUCTION RECORD	SIGNED BY INSPECTOR											

FIG. 141.—Inspection Ticket.

removed from the receptacle under the machine number at the bottom of the planning board, and is placed in the lower right-hand corner of the planning board under the heading "REC," signifying recall. This is a signal to the messenger to bring back all drawings, instruction cards, and tool lists from the machine or workplace to the planning department, where they are properly filed. It is a function of the foreman to see that tools are returned to the tool room at this time.

Upon the receipt of the final inspection ticket, there is issued the move ticket for the next operation as indicated by the route sheet, and a half check line is drawn under the move column for this operation. Upon the receipt of this move ticket, those in charge of shop transportation move the worked materials from the machine where the work has been completed to the machine or workplace where the next operation is to be performed. They then return the move ticket to the planning department, a full check line is drawn under the heading "move" for this operation, and all procedures, as explained above for the first operation, continue for the second and other succeeding operations in exactly the same manner.

If a job be interrupted and the operation postponed for any reason, the operation ticket is removed from the first hook and placed on the second hook, in conformity with the proper order of work. At the same time all drawings, instruction cards, and tool lists are recalled from the shop, if the delay is to be a long one. Such recall is accomplished through the removal of the pink operation ticket from under the machine number at the bottom of the planning board. This ticket is placed in the lower right-hand compartment headed "INT," signifying interruption. The messenger, observing the pink slip in this location, brings all papers from the shop and files them.

Control of shop conditions through the planning board. Shop conditions may be told at a glance by reference to the planning board if cards are provided, to be hung on that board, which will clearly give such information concerning each work station. For instance, there may be an operator's card, containing the operator's name and number, and a list of the machines or workplaces which he is qualified to operate or at which he is qualified to work. This card, hung on the first hook of the machine at which the man is working, gives the planning department an unusual ability to control men to best advantage, and particularly to suggest to the shop foreman changes of men between machines in cases of emergency. A card with the words "No Man" printed upon it may be hung under any machine where there is work to be done, but no operator available. A "Man Not In" card may be used to indicate that an operator is absent. A "Machine under Repair" card may be used to indicate that a machine is shut down for repairs. "Man to go on ——" and "Man coming from ——" cards may be used to show the planned transfer of workers from one workplace to another after a current operation is finished. These cards are usually in distinctive colors which will enable members of the planning department quickly to visualize shop conditions. Some plants, in place of certain of these cards, prefer a "Machine Inactivity Card," such as illustrated in Fig. 142, on which the relevant information may be checked. This card may be time-stamped and forwarded to the cost department for computation and distribution of idle time costs.

Description of important forms used in despatching. The time ticket serves more purposes than any other form used in despatching. It informs the worker of his rate (if this is not on the instruction card). It records the length of time consumed in the operation, and is, therefore, a basis for all cost computation and wage payment, and it is a vital link in the despatching system. The amount of information which must be placed upon it, therefore, is great, particularly compared to a ticket, such as

Ret.			Machine _____
Iss'd			Location _____
MACHINE INACTIVITY CARD			
Check Reason for the Inactivity of the Machine with Cross (X) in the Column to the Left of the List Below.			
	Lack of Man		
	Lack of Material		
	Lack of Work Assigned		
	Lack of Supplies		
	Machine Under Repairs		
Signed _____			
Remarks _____	Machine Time	Hourly Machine Rate	Inactivity Cost

FIG. 142.—Machine Inactivity Card.

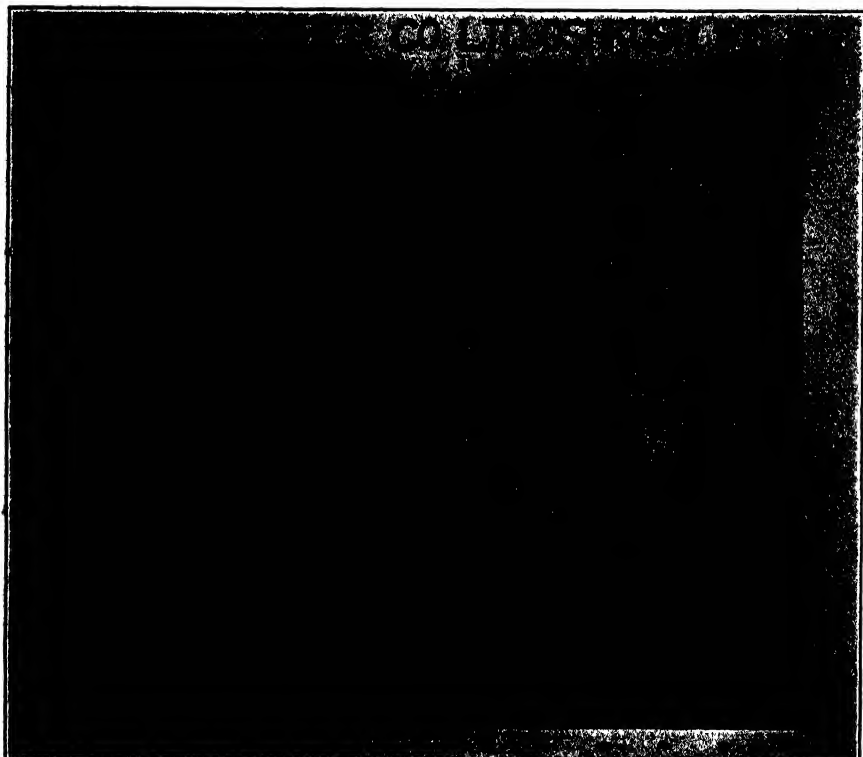
the operation ticket, which is used only for control. Duplicate copies of time tickets may well be used to replace operation tickets, unless it be felt that the larger amount of information on the time ticket may lead to confusion, or to using too much space on the planning boards. Figure 140 is an example of a time ticket which will indicate the basic information which is necessary on such forms. The order which is to be charged with the labor represented by the ticket must be indicated, as well as the operation number, which will make possible allocation of costs to operations

P2 ¹ / ₂ H		PHIB		TPHIB		M 1724		20,000	
LOCK No.		PART		OPERATION		ORDER No.		S W P	
QUAN-TY		WEEK ENDING							
EMPLOYEE'S No.		MACH No		EMPLOYEE'S NAME		TOOL No.		GAUGE No	
268		PH4				FT158		5845	
PREV MACH.		NEXT MACH.							
G7		PH5							
Mach No		Mch. No.		Act. Hrs		Std Hrs		Excess Hrs	
5		7		8		9		10	
11		12		13		14		15	
16		17		18		19		20	
21		22		23		24		25	
26		27		28		29		30	
31		32		33		34		35	
36		37		38		39		40	
41		42		43		44		45	
46		47		48		49		50	
51		52		53		54		55	
56		57		58		59		60	
61		62		63		64		65	
66		67		68		69		70	
71		72		73		74		75	
76		77		78		79		80	
81		82		83		84		85	
86		87		88		89		90	
91		92		93		94		95	
96		97		98		99		100	
101		102		103		104		105	
106		107		108		109		110	
111		112		113		114		115	
116		117		118		119		120	
121		122		123		124		125	
126		127		128		129		130	
131		132		133		134		135	
136		137		138		139		140	
141		142		143		144		145	
146		147		148		149		150	
151		152		153		154		155	
156		157		158		159		160	
161		162		163		164		165	
166		167		168		169		170	
171		172		173		174		175	
176		177		178		179		180	
181		182		183		184		185	
186		187		188		189		190	
191		192		193		194		195	
196		197		198		199		200	
201		202		203		204		205	
206		207		208		209		210	
211		212		213		214		215	
216		217		218		219		220	
221		222		223		224		225	
226		227		228		229		230	
231		232		233		234		235	
236		237		238		239		240	
241		242		243		244		245	
246		247		248		249		250	
251		252		253		254		255	
256		257		258		259		260	
261		262		263		264		265	
266		267		268		269		270	
271		272		273		274		275	
276		277		278		279			

ticket. At the bottom of the ticket there are check spaces headed "Route Sheet," "Pay Sheet," and "Cost Sheet," to provide for checking proper posting of the time ticket.

Many types of planning boards have been constructed. A simple board, which is effective and uses tabulating-machine cards for time tickets (Fig. 144), is in use at the Paine Lumber Company at Oshkosh, Wisconsin.

J. J. Davis, industrial engineer of this company has described ⁵ the operation of this board as follows: "The basis of the scheme is a job card for each operation to be performed on each job or order, on which is entered, on a special line, the time required for the operation. (See Fig. 145.) A heavy line of the proper length is then drawn through the scale to represent the time required. . . . On the left of the board all operations per-



Courtesy, Paine Lumber Company, Ltd.

FIG. 144.—Planning Board Using Tabulator Time Cards for Scheduling Work and Despatching Jobs to Workers.

formed in the department are indicated by symbols, together with the machines or other equipment upon which they are performed. . . . Across the top is a time scale corresponding to the scale printed on the cards. Hooks at top and bottom of the board hold an elastic tape to aid in locating current time. They are spaced for each half day. . . . If separate cards are desired for several workmen performing one operation, they are all filed together. . . . The cards for each order or lot are separated according to the length of the line drawn on the scale. The time required

⁵ The Society of Industrial Engineers Bulletin, Vol. 9, No. 11, p. 3.

for each operation determines the time at which succeeding operations may start, and at which similar operations upon other parts should start, and at which assembly may start without being delayed for parts. When all cards for jobs ahead are properly filed, the board then presents a complete picture of work ahead of the department. To aid interpretation of this picture, pink cards are inserted to indicate idle equipment and workers, which are changed to green cards when other work has been provided for the operators. A messenger or workman from each crew comes to the board with cards representing completed order or lot, and takes cards for new orders with complete instructions, leaving exposed a colored card filed back of work cards indicating job in process on each operation. The method of filing cards makes it very convenient to change the plan and

The form is a detailed job card used for planning and tracking work. It includes sections for:

- Job Information:** Job No., Operation No., and other identifying numbers.
- Time Scales:** A large section on the right containing multiple columns of numbers (1-9) used for time tracking.
- Operational Data:** Fields for 'ACTUAL TIME', 'STANDARD TIME', and 'PLANNED TIME'.
- Check Spaces:** Various boxes and lines provided for recording specific data points and ensuring accuracy.

Courtesy, Paine Lumber Company, Ltd.

Fig. 145.—Tabulator Job Card Used with Planning Board in Fig. 144. Note the time scale in the third horizontal field from the tip.

provide for machine breakdowns, absent help, variations in actual time consumed on any operations, etc. This feature of flexibility makes it possible to provide for such irregularities and emergencies with the least possible interruption of assembly or completed work, as well as to lay out the work in one way and then try to work out a better rotation."

Check spaces on forms. A most important part of any form used in control is the series of check spaces provided to insure the performance of all tasks that deal with the information covered by the form. Manufacturing orders, time and job tickets, and other forms which are the basis for a procedure involving two or more persons may all well have these check spaces provided. They not only permit quick placing of responsibility for errors made, but also prevent errors and oversight, and insure that once a procedure is started, all necessary steps in connection with it will be taken.

CHAPTER XLV

ADAPTATION OF PRODUCTION-PLANNING METHODS IN DIVERSIFIED MANUFACTURE

ALTHOUGH successful production planning necessitates an infinite attention to detail, as may be imagined from what has been indicated, strangely, more attempts at careful production planning have been wrecked in the attempt to reach 100 per cent perfection than from all other causes together. Since the purpose of production planning is to control operations in such a way that they will be performed on time and at lowest cost, care must always be exercised that planning schemes do not slow up production. If the planning system be so arranged that much time is taken by the workman in the exchange of job cards, or if there must be provided an inordinately large clerical force to handle the planning procedure, the difficulty probably is that the planning has been attempted on too exact a basis, and that in the attempt to reach exactness, costs have been increased. Ninety-eight per cent perfect planning is likely to prove more profitable than planning which reaches 100 per cent perfection. Thus, in routing work, alternate machines may well be indicated, though it will prove profitable to call attention to the excess costs of production on the alternate machine. In developing an order of work, if 100 per cent perfection be the goal, it is probable that alternate provisions for work for a machine will not be made, on the assumption that the work which has been planned ahead will always be ready. If 98 per cent perfection be set as the goal, the planning department will be likely to have made some general arrangements to take care of the hold-ups which will inevitably occur, and therefore, in the long run, the control of production operations will be smoother.

Minor modifications of the typical procedure. If any advantage is to be gained from the pages on order-of-work and despatching procedure, it is essential that the form be not misunderstood for the essence. These pages form a ready basis for adaptation and simplification. They clearly indicate a unified method of controlling all of the factors of production which must be currently controlled while an order is in process. One method of developing planning boards in a different manner has been described in detail. Some companies, instead of using planning boards with hooks, use pockets or boxes for distribution of tickets controlling

operations, as in Fig. 127. Many plants utilize a two-position planning board, rather than a three-position board, as described. In such cases, jobs are not posted until an operation is ready to be performed, the operation tickets being retained in file until that time. The balance of work, instead of being secured from a third position, is secured from some sort of a load chart.

Adaptation of centralized planning procedure. It was mentioned that the system of centralized order of work and despatching which has been described is an excellent one to consider, because of the clear separation, under it, of the control of each of the various factors of production. Some of the more frequent forms taken by adaptations of this procedure involve combination control over several of these factors, or the issuance of the control orders in a somewhat less formal way that often tends to speed up production.

Combination identification tag and move ticket. Inasmuch as the route which materials are to take is, in general, determined before the materials leave the storeroom, one of the first moves in changing the described procedure is usually the elimination of the move ticket. The identification tag may be somewhat enlarged, and on the back may be placed the route through the plant. As one operation is completed the move may be ordered by the inspector who has passed the materials, or if there is no inspection needed at that point in the process, as is often the case, the move man may receive orders to move from the shop foreman. In such cases the movement of the material is reported to the planning department at the same time that the inspection report or the job ticket is handed to them. They have continual knowledge of the location of the material, but they order the movement from each operation at the time that they first order the goods from the storeroom. This considerably speeds up production, and is very successful when the route is not subject to constant changes. If minor changes need to be made, these can easily be made on the identification tag when the goods are in process, by a representative of the planning department. Such a tag is illustrated in Figs. 146*a* and 146*b*.

Combination time, inspection, and move ticket. Some plants have retained the identification tag in its original form but have combined the move ticket with the time ticket. Possibly the inspection ticket is replaced by space on this same form (Fig. 147). Thus, when a time ticket is issued to a worker, there is noted on the bottom of the ticket the next operation and where it is to be performed. When the operation has been performed, the foreman directs the move man to take the materials to the location specified, and reports this action upon the form. Prior to such movement, the inspector will have inspected the operation and will make his report on the same ticket. Thus the planning department

need only order performance of an operation, and inspection and movement follow automatically. This gives the foreman somewhat more

DENNETTAGCO. WESTCHESTER, PA.

WORK TAG

This Tag must remain with Material through every Department.

Date Issued 4-18-23			
Order No. M6554			
Piece No. P2 1/2 H1 B			

Original Quantity in Lot	20,000	Balance Forwarded	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	
Removed in Oper.		Removed in Oper.	
Balance Remaining		Balance Remaining	

All time covering this Material must be charged to, and Production recorded against above Order No. and Piece Number.
RZ 239-200M-D.T.Co.

direction of the production process. It reduces the number of forms which have to be handled, and in most cases does not materially lessen the amount of planning-department control. Proper modifications must be made in such cases in the checking of progress on the route sheet and the issuance of new job cards to the worker. Time must ordinarily be stamped on the time cards by the foreman or his representative in the shop, and issuance of new job cards must be on the request of the foreman, as he sees that the worker is nearing the end of the job. This change is made necessary by the retention of the time ticket in the shop until after final inspection of the operation.

Location of despatch stations in the shop. In plants of any

FIG. 146a.—Combination Identification Tag and Move Ticket (Front).

size where central planning is retained, it is desirable to locate despatch stations in the shop, or to provide pneumatic tubes through which time tickets may be transmitted. Because of the expense of the latter and the desirability of direct contact between the workman and the man who is handing him his job, the first alternative is usually adopted. At times

despatch stations in the shop are provided even when there are despatch tubes, in order to gain the advantage of personal contact. If the worker comes to feel that there is some unseen hand telling him what to do, he is likely to complain much more readily than if he has the opportunity to see and know intimately the man who is handing out his work, even if the latter has no great authority. Some have felt that this leads to unnecessary conversations, and hence loss of time, but if it does, it is usually time well lost. Despatch stations in the shop do not imply decentralized control. They merely issue the tickets which they are told to issue by the central planning department. Perhaps they have some control over movement of material. At any rate, in large plants, they save steps and time for the worker. To have the worker come to the window of the planning department for his new time ticket is only possible in small plants.

• **Strip operation tickets.** Where the sequence of operations is practically standardized, regardless of the particular style of product being manufactured, as in a shoe or a hosiery plant, it becomes profitable to control operations in groups through the use of strip operation tickets.

	Operation	Workman	Inspector
PA 17			
PD 7			
PD 9			
MP 5			
T 2			
G 7			
PH 4			
PH 5			
PD 22			
G 4			
T 2			
X 8			
X 11			

FIG. 146b.—Combination Identification Tag and Move Ticket (Back).

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Such a ticket is illustrated in Fig. 148. This ticket is assigned a number and attached to the batch of materials as it is about to start through a series of operations. It has a coupon for each operation in the series. As the worker performs an operation, he detaches a coupon, part of which he usually gives to his supervisor for transmission to the planning department, and part of which he retains for purposes of checking with his pay envelope. This portion of the coupon for the worker is made necessary

RETURNED				CHARGE TO			
ISSUED				M 1318 F 4			
AP 34							
OPERATION NUMBER		7 MF		KIND OF OPERATION		Assembly	
A—PREMIUM .. LIMIT HOURS		2.48		MAN'S RATE		MAN'S TIME	
B—TOTAL HOURS TAKEN							
I HAVE INSPECTED THE ABOVE MATERIALS AND FIND THEM							
SIGNED BY INSPECTOR							
MOVE ABOVE MATERIALS From BH 1 To LE 3							
NO. OF PIECES MOVED				RECEIVED BY			

Fig. 147.—Combination Time, Inspection, and Move Ticket.

as there is no direct check with him to insure that he has received credit for the work that he has done. He only receives such credit as a batch of tickets is turned into the planning department. Where operations are short and must be performed in the same sequence, this gives all the necessary control for the planning department at at the same time allows the goods to flow through the factory promptly.

A number of different strip tickets can be provided for the whole sequence of operations, each ticket covering a controllable unit. The

FORM	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>22006</p> <p>Report Inspector</p> </div> <div style="text-align: center;"> </div> <div style="text-align: center;"> <p>Date</p> <p>Date</p> </div> </div>																																			
	6																																			
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%;"></th> <th style="width: 10%;">First</th> <th style="width: 10%;">Second</th> <th style="width: 10%;">No.</th> <th style="width: 10%;">Date</th> </tr> <tr> <td>Seconds</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>O. K.</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Topper M</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Machine M</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Looper M</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Total</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>		First	Second	No.	Date	Seconds					O. K.					Topper M					Machine M					Looper M					Total				
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Knitter Trimmer First Inspector Looper Second Inspec. Mender Re-Inspector																																				

	Style	Size		Doz.	Odds
22006	103	9 1/2			
	Inspector	5		Good	
	Re-Inspector			Mended	
	Mender			Total	
	Style	Size			
	103	9 1/2			

22006	Date	Style	Size	Doz.	Odds
		103	9 1/2		
	Re-Insp.				
	Doz.				

22006	Date	Style	Size	Doz.	Odds
		103	9 1/2		
	Mender				
	Doz.				

22006	Date	Style	Size	Doz.	Odds
		103	9 1/2		
	Sec. Inspec.				
	Doz.				

22006	Date	Style	Size	Doz.	Odds
		103	9 1/2		
	Looper				
	Doz.				

FIG. 148.—Strip Operation Ticket.

order of work can be maintained throughout the sequence of operations covered by one ticket, if the numbers on the tickets correspond with the order of work, and if the batch or lot of goods with the lowest serial number is put through each operation first. Manifestly, serial numbers can be changed at the end of each series of operations. Movement of material at the end of a series of operations must be on separate order from the planning department, as in the case of any other system. Where inspection is necessary after operations, it is usually treated as one of the operations covered by the strip ticket.

Operation of decentralized planning control. Decentralized planning control is always a necessity in very large plants, and where entirely different types of businesses are carried on within one building, as in the case of the manufacture of stationery and the boxes in which the stationery is sold. Decentralized control is frequently set up when it is the desire of the management to allow the foremen to maintain a considerable share of the task of planning work. It has already been indicated that the development of the master schedule and routing between departments are functions which must be performed centrally. Portions of the other planning functions may be decentralized.

Routing to machines is the planning function which is most frequently left to the department planning supervisor. If this function be given to him, of necessity much of the operation of the order of work will automatically go with it. If there be decentralized control, despatching to the worker will always be done within the department. If routing is to be given to the shop planning supervisor, whether he is or is not under the control of the foreman, there are usually certain operations which must be routed centrally. These are the key operations, or operations which may only be done on one or two machines. This is necessary to prevent throwing the shop out of balance.

If there are departments which have large batteries of the same kind of machines, all capable of doing essentially the same kind of work, ideal conditions for decentralized routing are found, because the foreman or the shop planning supervisor will ordinarily be in a much better position to determine the machine to which a particular job should go than would be the central planning department. In such cases, the routing of material to the department, always a function centrally performed, is in reality routing to a particular group of machines. The decentrally controlled routing takes on the nature of a despatching function, which will indicate the machine of the group, which, from the standpoint of shop conditions, is best able to take on the particular operation. If routing of this nature be done decentrally, the central route sheets will ordinarily only indicate departments, not machines, while there will be no necessity of maintaining route sheets within the department.

The planning station in a department of a shop operating under decentralized control may maintain a planning board which is similar in almost every respect, including operation, to the central planning board already described, except that it will cover only the machines and work-places of the one department. If such boards are maintained departmentally, then there will be no need for the central board. This will be replaced by some sort of progress chart which will indicate the operations to be performed, by departments, and the progress that has been made upon them. Progress charts of this kind have already been described.

Under decentralized control, movement of materials between departments may be ordered by the departmental planning unit, but after consultation, usually by telephone, with the central planning force. However, each departmental unit will ordinarily have a move man under its control. Movement of material from stores to the first department in which work is to be performed will usually be ordered by the central department. If work be moved from a production department to a separate inspection cage, under decentralized control, the department planning unit will usually order the work into the inspection cage, while the ordering of the work out of the inspection cage to the next department will frequently be left to the central planning group.

There are no new planning concepts involved in decentralized control. It is only a means of making the control run more smoothly under the conditions which have been mentioned. Nominally, the foreman is usually put in charge of the departmental planning under this arrangement. Nevertheless, the planning clerk in the department, who is nominally supposed to report to the foreman, is usually given such complete control of planning by him that he is, to all purposes, wholly a representative of the central planning department in the shop. Besides correlating the work of the department with the central plans, he will make reports of progress on work under way, which will enable the central department to post any records of progress which they may maintain. In any case, he is a force working toward flexibility in planning.

CHAPTER XLVI

PLANNING IN STANDARD QUANTITY MANUFACTURE

ALTHOUGH the same functions must be performed in planning for standard quantity manufacture as in any other types of manufacture, yet, because of the fact that the machinery is set up, and then continues to produce as long as material, power, and labor are present, actual day-to-day planning is simplified. It is in the original development of the manufacturing process and in the layout of the machinery that the greatest problems arise. Since it is the automotive industry that has developed this type of production most completely, it is also that industry which has developed, to the greatest extent, production methods suited to the process.

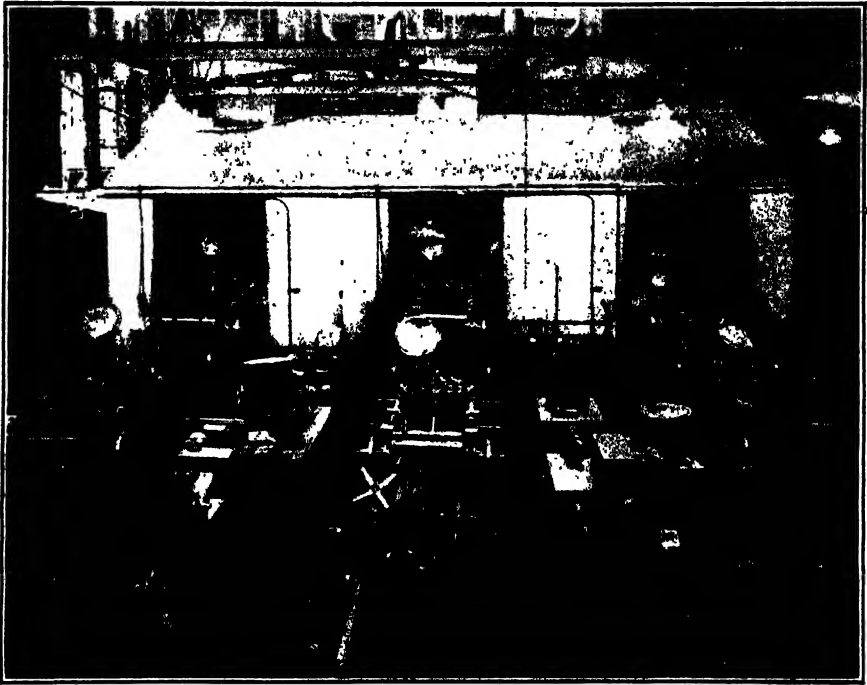
Some attention has already been given production problems in such industries in the chapters on layout, inspection, production control, and scheduling. However, because of the necessary difference in treatment of production problems in quantity manufacture, such treatment will be described fully.

An example of standard quantity manufacture. The unified assembly line of the Buick Motor Company at Flint, Mich., is an outstanding example of the production methods of such a plant. A building 80 feet wide by a half-mile long houses three assembly lines, side by side. Each line requires floor space $13\frac{1}{2}$ feet wide. Nearly 1000 men work on these lines, producing about 120 Buick cars an hour.

Frames, brackets, and other parts, properly drilled for riveting are brought to the riveters by power truck. Three men on either side of the frame rivet the parts to it. As they finish, the frame, on a wheeled stand, is pushed on to tracks on one of the assembly lines. Workmen put front and rear springs and brake drums into place. The frame is then taken off the wheeled stand and attached to an endless-chain conveyor. As the frame passes down the assembly line other parts are added. From a mezzanine floor, similar to that illustrated in Fig. 19, page 107, a rear axle is lowered. It finishes its downward journey just as the frame comes into place beneath, and it is placed in position. Overhead in the mezzanine, final inspection is being made on other axles, which come to that point on a conveyor from another building. The front axle and the

steering-wheel assembly come from mezzanines also. Following these comes the engine assembly from another mezzanine.

The engines have been brought from the block test on a conveyor over 3000 feet long. Despite the heavy load, this conveyor is operated with a 2-horsepower motor. This indicates why conveyor transportation is not costly. Brake rods and cables are added as the frames move forward. Oil aprons and the muffler and exhaust are next added. The fly-wheel is added, and the chassis is ready to be cleaned by steam as it moves



Courtesy, Buick Motor Company.

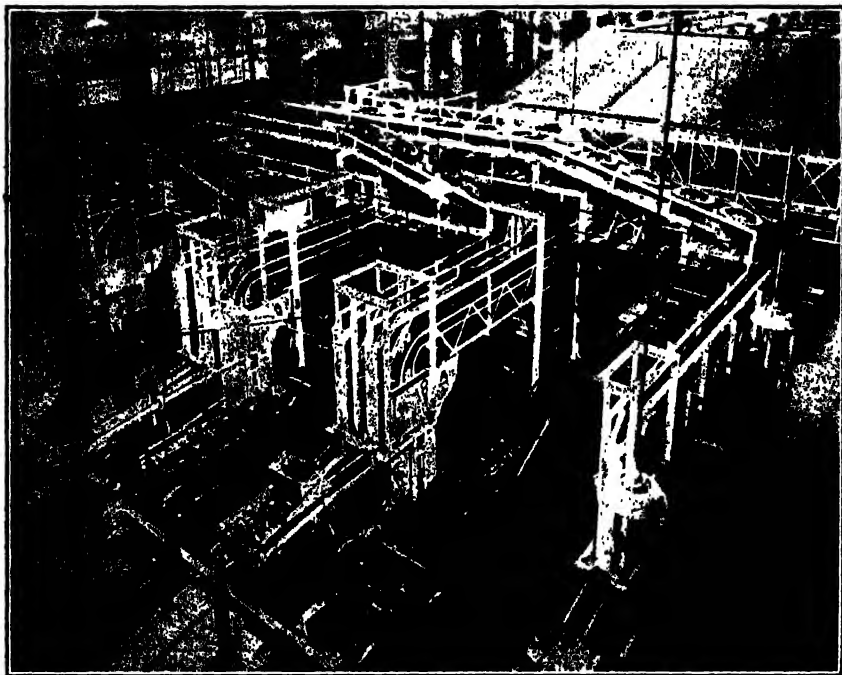
FIG. 149.—The Three Lines of Cars that Make Up the Buick Unified Assembly Line Pass into the Steam Cleaning Room.

along. (See Fig. 149.) Next, the chassis is painted, and the paint is dried in a long oven built around the assembly lines. The wheels, with tires attached, then roll down narrow chutes from a mezzanine. (See Fig. 150.) The fan belt, batteries, and gas tank are put into place. As the car rolls along, engine connections are made, as are brake adjustments. The radiator swings into place from above. A fender, running board, and splash apron come down as one unit and are attached.

The body next descends accurately into place from the floor above. The fenders, headlights, and other final parts are added, and the car,

with gasoline in its tank, rolls off the assembly line under its own power. Many other cars are assembled in a similar manner.

Cost savings through quantity production. If the market is sufficiently large, and if the company has the managerial ability and financial strength to produce a dependable product in any quantity demanded, and if the product can be made so that it catches the imagination of the public, the volume of sales will increase inevitably. As the volume of sales increases, it becomes economical for the company to specialize more



Courtesy, Buick Motor Company.

Fig. 150.—Bringing Wheels to the Buick Assembly Line. The wheels can be seen coming from another building on conveyors. Each wheel as it leaves the conveyor, drops into a track which carries it to the assembly floor, where it rolls by force of gravity to a convenient position for the workers.

completely in manufacturing method, introducing many labor-saving devices, such as those in the Buick factory. With the introduction of these labor-saving devices at various points, a reduction of the cost of the product is inevitable. With this decrease in cost, the company can, of course, reach a still wider market, this sequence continuing to the point where an increase in output would not result in a material decrease of cost. This point might be reached in a number of different ways. As the company expanded in size, the difficulty of co-ordinating the various functions

might increase, and with it overhead. Or an increase in the volume of materials purchased, after a given point, might not result in a decrease of cost, but merely a duplication of production units.

Scheduling quantity production. The master schedule in such manufacturing is very simple, merely a sheet of paper showing the number of each type of automobile to be made in a given month or months. This master schedule is broken up into components by the production department. If 1000 automobiles are to be made in a given month, 1000 crankshafts will be needed, but there will be 4000 wheels needed. Presumably there will be sufficient of each type of equipment in the factory to make the relative numbers of each part that is to be made within the plant. The planning department must see that the schedule does not call for larger amounts than the capacity of the equipment or assembly lines. If this should happen, the general management must decide whether additional capital is to be invested in equipment to meet the increased load, or whether the emergency is to be met by overtime, or letting out more parts to be made on the outside.

The Purchasing Department and the Materials Department are given copies of the schedule broken down into components. That is the necessary authority to purchase in quantities sufficient to cover the schedule. No maxima, minima, or apportioned amount are necessary, as each series of purchases will just cover a particular production schedule, with proper allowance for material spoiled in manufacture.

The schedule is broken up according to the time that components and operations on these must be started, in order that assembly lines may have all components as needed. Daily quotas for each component are then set, these bearing a direct relation to the master schedule. In many plants, deliveries are arranged so that only two or three days' supply of any purchased material or component will be on hand at a time. Manufacturing operations on components are laid out in the same manner. This reduces to a minimum the amount of capital tied up in materials, and it also reduces the amount of storage space needed.

Figure 151 is a time distribution schedule for a body factory, indicating the number of days ahead that various materials must be ordered and operations must be completed for bodies for two different automobile plants, A and B.

Job departments in quantity production plants. There are always certain operations or parts which cannot be controlled according to this method. For instance, on small punch-press articles, it may be possible to produce a month's requirements in a few hours. Such items are turned out by job shop departments, which are diversified manufacturing sections within the standard, quantity-production plant. Their operations may be handled in accordance with methods already described.

AUTHORIZATION	A (Days)	B (Days)
1. Lumber.....	158	168
2. Malleables and Steel.....	122	132
3. Body in White Stock.....	98	102
4. Trimming Material.....	104	102
5. Glass.....	128	132
6. Body Fittings and Final Assembly Stock....	104	102
ORDERING AND PURCHASING		
1. Lumber.....	152	162
2. Malleables and Steel.....	116	126
3. Body in White Stock.....	92	96
4. Trimming Material.....	98	96
5. Glass.....	122	126
6. Body Fittings, etc.....	98	96
STOCK RECEIVED		
1. Lumber.....	110	120
2. Malleables and Steel.....	56	60
3. Body in White Stock.....	56	60
4. Trimming Material.....	26	30
5. Glass.....	26	30
6. Body Fittings, etc.....	26	30
WOOD MILL MACHINING		
1. Body in White Stock.....	52	60
2. Mouldings.....	56	60
3. Body Fit Stock.....	26	30
MACHINING		
1. Body in White Machining.....	46	48
2. Body Fit and Final Assembly Machining.....	14	18
BODY IN WHITE		
1. Set Up.....	39	36
2. Bodies Finished.....	29	30
3. Mouldings.....	40	48
COLOR VARNISH		
1. Bodies.....	First 10	Last 18
2. Mouldings.....	18	24
TRIMMING BODIES	4	13
FINISH VARNISH.....	—	5
FINAL ASSEMBLY.....	1	1

The above figures are based on working days only, and do not include either Sundays or holidays.

FIG. 151.—Time-distribution Schedule.

Material control. In considering purchasing (p. 429) it was pointed out that in quantity-production plants, delivery dates for a given order may extend over some time, and that consequently but little paper-work is necessary in handling stores in such plants. Follow-up of purchasing is responsible for seeing that materials are delivered in time to meet the requirements of schedules.

Professor Charles B. Gordy of the University of Michigan has pointed out that, "Stock records can be arranged in a manner that will facilitate greatly the follow-up. The issuing of a requisition for each batch of material leaving the storeroom results in too much clerical detail, in the case of the larger part of material used in assembling an automobile. Material can be charged from the stock records on the basis of the number of cars or units produced during a week or month, by breaking up this amount of production into the component parts of a complete unit. Certain companies have gone a step farther, and disburse stock on the basis of the manufacturing schedule in advance of building. This gives the follow-up department a knowledge of any shortage existing at the beginning of the month and gives sufficient time in which to expedite deliveries."¹

The layout of such plants should be so arranged that there need be no finished-parts storage. The equipment should be balanced so that there will be exactly enough parts produced daily for assembly requirements, and these parts should have the last operation performed on them so that they are available immediately for assembly, being finished either adjacent to the point of an assembly line at which they are used or near a conveyor which takes them to that point. Of course, this ideal cannot be reached exactly, and it is necessary to have some finished parts banked near the point of usage to guard against temporary breakdowns.

Planning department functions in quantity manufacture. It is evident that the functions of the planning department of a quantity-production plant will differ considerably from those of a planning department in diversified manufacture. In quantity production its functions are mainly to work up the schedules, to tell the various department foremen how many units they will be required to make in a specified time, and to maintain records to insure that the schedules are being followed. As in the case of any planning department, time study and material control may not come under its direction. It is not necessary, owing to direct line layout, to control work between machines to any considerable degree. It is obvious that, because of the similarity of the work put through the plant for a long period of time, the planning department is only breaking down into units the major business budget.

Only a few types of manufacture can be put on a quantity basis, such as that just described. It will be evident that such a basis is profitable, not only because of lowered direct production cost, but because the costs of production control are much less than in diversified manufacture.

NOTE: Special acknowledgment is made of the assistance given by Professor Charles B. Gordy, School of Mechanical Engineering, University of Michigan, in the preparation of this chapter.

¹ The Journal of the Society of Automotive Engineers, Vol. XVI, No. 6, p. 607.

CHAPTER XLVII

MANAGEMENT CONTROL THROUGH COSTS

THE yardstick by which operating effectiveness must be measured is the cost of performance. To this end the science of cost accounting has striven, and has provided data which may be utilized as a large portion of the basis of operations. Business tragedies which have resulted from attempting to operate without a developed cost system have demonstrated the necessity of cost collection and analysis to the complete satisfaction of the manufacturing community. Cost accounting has developed as the companion science of management and as the staff on which management must lean for many of its most important decisions. The highly developed technique of cost accounting cannot here be given adequate attention. Means of cost collection have been indicated, but the technique of analysis of costs and their relation to the general books of the company are important accounting problems which must be considered separately and at great length. Such consideration must be left to texts on cost accounting. We are concerned with costs as an instrument of service to the manager, as a means of reaching operating decisions, and as a guide in control.

Though cost accounting forms the soundest groundwork for information on which management decisions may be based, and profits insured, like other business methods, it is not an aim in itself. It is only of value in so far as it aids in operations and in the making of intelligent executive decisions which will promote the healthy advancement of the business. No cost system, however elaborate, can itself insure these decisions or this advancement. Cost reports, regardless of their value, are inanimate and cannot themselves make betterments or insure intelligent operation. They must be studied by the executives and translated into the action toward which they point. They give the information for control, but they cannot themselves do the controlling. This point of view is important, for all too frequently an elaborate cost system has been set up without the means being provided for following up the reports which result. Sometimes the elaborateness of the system itself has defeated its own ends, because final cost reports have been submitted at such a late date as to be useless as a basis for action. Cost reports must be on current periods if they are to serve for management control, in order that action may be immediate and in order that the business ship may be steered around the

reefs which the reports have indicated to be immediately ahead. Post-mortem cost information may tell why some business catastrophe happened, but it will never prevent its occurrence.

In order to serve as the basis for management control, it is essential that the cost system be developed with a view to its utilization primarily for that purpose. In order that management control may be sound and the business be guided into safe channels, there are some fundamental ideas concerning the utilization of costs for guiding operations which must be thoroughly understood. This final chapter will indicate the most essential phases of these relationships.

The cost system as related to the organization of the plant. Regardless of the construction of the cost-accounting system, it must be such that individual and departmental responsibility may be closely checked. It may be that costs will be collected primarily on the basis of manufacturing orders, rather than departments. This will be wise in all cases of diverse production where customers must be quoted on orders, and will be useful under many other conditions. Provision must be made, however, for the collection of information which will enable careful check-up of responsibilities which have been delegated. This information may cover not only the routine responsibilities, such as departmental operation at lowest unit cost, but also special responsibilities, such as may be assigned in the preparation of a budget. If new functional departments are constructed, or if development programs are undertaken, the cost system must allow computation of the savings effected through the changes. Otherwise these new departments or new work may have difficulty in establishing and holding the esteem of other branches of the business, particularly any of them that may have opposed the change prior to its consummation. Thus, if job-study work be developed, it will be most desirable to be able to balance the cost of the taking of the studies against the savings through lower unit costs on those operations which are studied. If a planning department be instituted, it should be possible to know the savings in direct and indirect labor in the factory departments which have resulted from the expenditures incident to the creation of the planning force. Such information becomes of particular value as planning work is extended, since it meets opposition successfully when the planning department has proved its value, and prevents hasty extension when conditions demand a higher degree of success with work already undertaken, rather than the taking on of new work.

The cost-accounting department should be in a position to furnish valuable statistical information, or, if there be a separate statistical department, to give this department the basic data from which the statistical information may be gathered. The personnel department should be able to gain accurate information concerning the actual cost of replacement of

workers. As has been seen, this is partially dependent on the lower productivity of new workers, and the amount of spoilage which can be attributed to having a "green" operator on the job. Such information can be secured most logically from the cost records. Although it may be taken off the production records by the planning department prior to the time that these are turned over to the cost department for costing, nevertheless this is primarily a cost problem. Such studies are only samples of the way in which cost information may be utilized to enable the organization, as constructed, to operate more smoothly. The personnel department will be able to determine the necessary care in selection for particular jobs, and to follow up the effectiveness of its own operation far more successfully, if it have such information at hand.

If modern management is to be most effectively developed, it is particularly important that no cost reports be rendered which will stress only the proportion of direct to indirect labor expenditures. Some cost systems seem to have been developed with this as one of the primary objects. Indirect labor is never unproductive if it returns in savings more than the added cost of its utilization. Inasmuch as there is a natural tendency, which is wise, to question indirect labor, it is essential that cost reports shall not handle indirect labor merely as an expenditure to be compared with direct labor charges. Thus the total of indirect labor charges need not be scrutinized half so carefully as the individual items, but these should be carefully analyzed, and compared with savings in a manner similar to that just indicated. The proper relation of direct and indirect labor expenditures varies, of necessity, from industry to industry and from one department to another. As labor-saving machinery is developed, the percentage of indirect labor to the total naturally rises. Improvement in management method operates in much the same way, and both improvements make comparison of these expenditures on the percentage basis wholly unwise.

In periods of depression when the payroll must be cut at all hazards, and regardless of ultimate cost, departmental analysis of costs which indicate savings effected under different operating conditions, as well as actual expenditures, make possible intelligent pruning of the payroll, rather than the hit-or-miss methods which are inevitable if analyzed data be not available.

Standard costs. As an aid to simplification of cost-accounting procedure and the fixing of the selling prices for products, one of the more recent cost developments has been the setting of standard costs. That is, the normal expenditure for material, direct labor, and overhead charges for a given product, or for a number of hours' production in a given department, is computed. This allows the elimination of much detailed cost analysis, and at the same time permits adjustment at the end of a period

through the totaling of actual departmental cost during the period and comparison with the normal or standard cost. If the actual cost of a given job performed during the period be wanted, this may be secured through applying the ratio for the period between normal and actual cost of all jobs to the particular job in question. Such a system is valuable because it permits the formulation of long-run production and sales policies which are not disturbed by minor fluctuations in operating conditions, and it furthermore makes possible the separation of normal production costs from costs which are due to the position in the business cycle or general efficiency or inefficiency in the management as a whole.

If an attempt be made to secure an absolutely accurate cost on each order, a cost that shall currently absorb all overhead or indirect charges, a fluctuating cost necessarily results, and this makes difficult the determination of long-run business policies. With a plan of standard costs, prices remain fairly constant, and losses or gains in operation are directly chargeable to the general business accounts which are responsible for them rather than to the departmental or other accounts which have had no responsibility whatever for the conditions as they exist. Thus volume of business comes to be figured in terms of hours of production and quantity of product, rather than in terms of dollars of business. This is a far more accurate estimate, because dollars of business is always likely to include a more or less constant fixed overhead burden.

Under many cost systems wherein overhead costs have been largely pro-rated as business is carried on, overhead costs have not been added in sufficient quantity when business was good, thus cutting down selling prices and prohibiting the establishment of a reserve for bad times. Similarly, they have been added too heavily in times of slight production, with the result that costs have increased as selling has become more difficult. Frequently, managers have realized the impracticability of spreading overhead over a greatly diminished product, and have charged a large share of it directly to the profit-and-loss account. They have less commonly kept their overhead up during times of prosperity, so as to create for themselves a reserve to which they might charge the unabsorbed overhead of times of depression.

The Chamber of Commerce of the United States has been active in advocating the use of standard costs. In a booklet published by their Department of Manufacture, entitled, "Cost Accounting through the Use of Standards," appear the following paragraphs:

"The need for standards of costs has become increasingly important and apparent. Many progressive executives are no longer satisfied with monthly profit and loss statements and balance sheets and the costs of individual products and parts, although only a few years ago executives who had these statements were far in advance of manufacturing executives

generally. Of course, these statements are useful and have not been superseded. The periodic profit and loss statement unquestionably gives the executive a sense of protection. The balance sheet informs him of his financial condition. But in many cases the costs of products obtained by the job-order method are hardly convincing, even for the purposes of comparison with existing sales prices.

"The difficulty that confronts the executive throughout is the lack of standards, both with respect to the figures that are presented to him and with respect to those important phases of operation about which he usually has little information available.

"It is the purpose of the predetermined or standard cost method to correct this situation and to reveal to the executive the important facts about the operation of his plant, these facts being compared with predetermined standards. Under this plan emphasis is placed on those vulnerable points in factory operation where failure to attain or exceed the standards will mean loss or inadequate profit. The method, in its most satisfactory form, proceeds to disclose this information through the principle of exceptions, that is, by putting before the executive the significant variations from standards, rather than by presenting him with the full range of operating statistics, most of which under careful and effective operation will be in satisfactory agreement with the predetermined standards."

Idleness expense. Standard costs have been developed with the idea of eliminating fluctuations from the selling price of products, in so far as this is practical. To secure full benefit from the utilization of this idea, a rather full study must be made of idleness expense, and this then becomes one of the primary objects of the cost system. The reports on costs of idleness give the general management much of the information with which to direct its general policies. If the plant be operating on part-time only, the cost of maintaining the portion of the plant which is idle must either be taken up in the selling price of such articles as are manufactured, or must be charged directly to profits. There has been much thought of "absorbing" overhead—too much for the good of general managements. Of course, overhead expenditures must be taken care of; but if they are absorbed in the product being manufactured, the causes of idleness and of the increased unit overhead charges are not likely to be brought to the attention of those who are in a position to correct them. If these charges be directly listed under some such heading as idleness expense, they will force themselves to the attention of the chief executives for correction, and selling prices can be fixed to include some of this cost of idleness or to exclude it entirely, as may be deemed wise under the conditions which prevail. This will be determined largely by considering whether the product can be sold in competition if the expense be added on.

The system of planning which has been described is of inestimable value in securing information on which to develop idleness-expense charges. The planning department is not only able to give to the cost department information concerning equipment which is idle, but is in a position accurately to determine the cause of the idleness. It only remains for the cost department to compute the cost of idleness and to render reports to the responsible executives. The latter may then take the necessary remediable action to attempt to cut down or eliminate the idleness which exists. A certain proportion of this will be found to be due to lack of sales, which may or may not be remediable. On the other hand, an intense analysis of the data will indicate the cost of ineffective operation of the purchasing or inventory control, of the maintenance department, of the planning department, or of the personnel department. Of course, the necessary information concerning causes of idleness could be secured without reference to the cost department, but the inclusion of cost figures not only gives the information attention value, but allows comparison with the cost of taking steps to remedy the conditions causing the idleness.

Fixed and variable costs. Variable costs, which change almost in proportion to the amount of business done, include direct wages, direct labor, and certain types of indirect expenses, such as the salaries of minor executives who are easily dropped in times of poor business, and income taxes, which vary almost directly with business done. Fixed costs remain constant, almost irrespective of the amount of business done. These costs include not only the salaries of major executives, but interest on investment, particularly borrowed money, taxes on property, and obsolescence charges on both materials and equipment. Cost reports should clearly differentiate between these fixed and variable costs. Although the rendering of idleness expense reports will partially cover this field, nevertheless both the cost department and the interested executives should have in mind constantly this distinction between variable and fixed costs. Any reports that clearly separate them will be of major assistance in the formulation of sales and production policies and of administrative budgets.

During the determination of major policies, fixed costs must first be covered by receipts from sales in income computation. Thus, if fixed costs are \$2000 per week, and sales are \$5000 per week, there is left a balance of \$3000 for the payment of variable costs and profits. Although variable costs vary with the volume of goods sold, yet for any given unit of goods they remain practically constant. That is, for 50 units they would be practically double the amount that they would be for 25 units. They vary proportionately with the amount of goods produced. The variable cost per unit may be readily determined approximately. Assume that the \$5000 of sales represents 50 units of product, the variable cost per unit of which is \$60. This will give a variable cost of \$3000 to be

applied to the week's sales. Inasmuch as this is the exact amount remaining after deducting fixed costs from sales, it follows that the week's business was done practically at cost. If \$7500 of business were done, there would remain \$5500 to be applied to variable costs, which at \$60 per unit would be only \$4500, and \$1000 would remain for profit. If \$4000 of business were done, there would remain but \$2000 to be applied to variable costs, which would be \$2400, and there would be a loss of \$400 on the week's business.

Although computations such as the foregoing can only be used as approximations by the management, yet they are valuable in the formulation of major business policies, and cost statistics should be prepared with a view to their use as indicated. In most businesses, the computations will not be quite so simple as the illustrations, inasmuch as fixed costs will not remain exactly fixed, and variable costs may not remain the same per unit of product. As production increases, the variable cost per unit will be likely to decrease somewhat. Possibly some variable costs will remain constant per unit of product and some will decrease slightly. In some cases, these variable costs of different types would have to be segregated in the cost reports. Tables can be prepared which will indicate the variable cost per unit at different points in the production scale, as well as modifications in fixed cost which are likely to occur as production changes. With these data to utilize, the general management will be in an excellent position to determine general sales and production policies, although the information thus obtained will not be exact enough for the accurate fixing of selling prices. Thus a consideration of fixed and variable cost is mainly useful as a guide-post for the formulation of major business policies.

Cost of production has frequently been the only figure shown by cost reports. Consideration of the paragraphs on idleness expense and those on fixed and variable cost will quickly indicate that, for management purposes, reports on the cost of not producing are quite as important as reports on the cost of producing.

The cost system and the budget. The administrative budget, which serves as the co-ordinating control over all operating departments, must necessarily be based on cost figures. This not only shows the necessity of keeping the cost figures up to date, and having a system of collection which will allow costs to be kept up to the minute, but also indicates the extent to which management control is dependent on costs. In making the budget, the cost records of past years give dependable information, but the current cost figures must be utilized in laying out the program for the months to come. Cost records during a budget period can be carefully analyzed only in the light of the budget which was prepared as the target. The cost record becomes the progress report on obligations

fulfilled by department heads, and permits modification of operating procedure or change of business plans during the course of a budget period. This again indicates the necessity of developing cost records so that they will be comparable with the organization of the business.

The new business era is one of competition, of profits through effectiveness of operation rather than through control of some major resource or important process. Although no particular phase of sound management will alone insure successful operation, nevertheless all operating decisions must in the end be based on costs. Thus, accurate reckoning of costs becomes the basis on which the expediency of management steps and decisions is determined. And costs must not only be reckoned accurately, but in ways which will permit their utilization for the formulation of management policies and the execution of management programs.

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